AQUIFER PUMPING TEST REPORT
SYLVAN SLOUGH PROJECT SITE
ROCK ISLAND, ILLINOIS

September 1995

Prepared for

United States Environmental Protection Agency Region V
Emergency Response and Removal Branch
77 West Jackson Boulevard
Chicago, Illinois

Prepared on behalf of

Navistar International Transportation Corp.
455 North Cityfront Plaza Drive
Chicago, Illinois

and

Burlington Northern Railroad
4105 North Lexington Avenue
Arden Hills, Minnesota

Prepared by

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WESTON
DESIGNERS CONSULTANTS

SHEET ____ of ____

CLIENT/SUBJECT ______________________ W.O. NO. ____________

TASK DESCRIPTION ______________________ TASK NO. ____________

PREPARED BY ________	DEPT ________	DATE ________	APPROVED BY
MATH CHECK BY ________	DEPT ________	DATE ________	________
METHOD REV. BY ________	DEPT ________	DATE ________	DEPT ________ DATE ________

11-3-95

Jim Duer to be replaced by

Marty Hamper - a hydro

Talked some about long-long term remediation

Bio-remediation

* Waiting on ~~pil~~ my comments on pilot study

report received in Sept.

* letter on time extension giving approval to a 9mo time extension

calling for a "Bundling" of design/construction

phase to perhaps cut down time.

GERAGHTY
& MILLER, INC.
Environmental Services

A **Heidemij** company

September 29, 1995

Mr. Ken Theisen
USEPA Region V
Enforcement & Emergency Response Branch
77 West Jackson Boulevard
Mail Code HSE-5J
Chicago, Illinois 60604-3590

Re: Sylvan Slough Site, Rock Island, Illinois
Administrative Order on Consent
Docket No. V-W-94-C242

Dear Mr. Theisen:

In accordance with the project schedule stated in our April 15, 1995 letter and later amended in our August 1, 1995 meeting, Geraghty & Miller, Inc. has completed the groundwater pumping tests at the Sylvan Slough Project Site located in Rock Island, Illinois. Enclosed please find three copies of the *Aquifer Pumping Test Report*.

If you have any questions related to the information presented herein or require any additional information, please do not hesitate to call me or Mr. Greg Vanderlaan.

Sincerely,

GERAGHTY & MILLER, INC.

James P. Auer
Project Engineer

cc: Edith Ardiente/Navistar
Greg Jeffries/BNR
Cary Perlman/Latham & Watkins
Jake Holdreth/Oppenheimer, Wolff & Donnelly

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September 1995

Prepared by GERAGHTY & MILLER, INC.

Raymond M. Flynn
Staff Hydrogeologist

James P. Auer
Project Engineer

James A. Hill
Associate/Principal Scientist

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INTRODUCTION

Geraghty & Miller, Inc. was retained by Navistar International Transportation Corp. (Navistar) and Burlington Northern Railroad (BNR) to perform the aquifer pumping test pilot study activities described in the approved May 1995 Pilot Study Work Plan (Geraghty & Miller 1995a). Navistar and BNR have jointly entered into an Administrative Order on Consent (Order) with Region V of the United States Environmental Protection Agency (USEPA) to stop the discharge of oil from the Navistar, BNR, Quad City Industrial Center (QCIC), and Iowa Interstate Railroad, Ltd. (IIR) properties (Sylvan Slough Project Site) located in Rock Island, Illinois into Sylvan Slough, a tributary of the Mississippi River. Figure 1 depicts the location of the Sylvan Slough Project Site and Figure 2 defines the property ownership in the vicinity of the site.

The aquifer pumping test was performed as part of the continuing efforts of Navistar and BNR to evaluate the Sylvan Slough Project Site to determine the most effective means of stopping the discharge of oil into the slough. This Groundwater Pumping Test Analysis Report has been prepared to describe the field activities that were conducted, interpret the additional hydrogeological data that was gathered during the field activities, and present an analysis of the aquifer pumping test data. This report has been prepared to fulfill the obligations of Navistar and BNR under the terms of the Order.

Based on the data collected during the Initial and Phase II site investigations and the analysis presented in the Phase II Site Investigation Report (Geraghty & Miller 1995b), the remedial alternatives evaluation indicated that the installation of an active groundwater recovery and treatment system at the Sylvan Slough Project Site would likely be the most effective means of preventing the discharge of oil to the Sylvan Slough. The active groundwater recovery system would consist of a line of recovery wells placed along a transect running parallel to the slough in an east-to-west configuration. The aquifer pumping tests were performed to determine if the proposed alternative was feasible. The aquifer pumping tests were conducted to:

- determine the hydraulic properties of the aquifer near the bank of Sylvan Slough where oil and oil residuals are discharging to the river;

- determine the feasibility of remediating the site by means of a line of recovery wells installed along a transect running parallel to the slough; and,

- determine if pumping is feasible at the Sylvan Slough Project Site.

To meet the objectives stated above, the Work Plan for the aquifer pumping tests was divided into three tasks:

1) monitoring and recovery well installation;

2) aquifer step and constant rate tests; and

3) aquifer pumping test analysis.

The well installation task consisted of the completion of three initial test borings across the site in an east-to-west configuration along the proposed line of recovery wells to serve as test sites for the location of the recovery (pumping) wells to be used in the aquifer pumping tests. The Work Plan called for the test borings to be completed as monitoring wells along with the installation of a fourth monitoring well between the line of initial test borings and the slough. The hydrogeology in the vicinity of the water table at the three test boring locations would be characterized and the locations most likely to have the ***highest*** and ***lowest*** transmissivities would be identified by:

- visually describing and logging soil samples collected on a continuous basis from the surface to the bottom of each test boring (well) location;

- performing grain-size analyses on selected soil samples from each test boring (well) location; and,

- performing slug tests at each location.

The Work Plan called for the installation of a recovery well at the observed high and low transmissivity locations *if* there was less than one inch of product in the corresponding observation wells. If a location showed more than one inch of free product, then that location would be rejected as a recovery well location. If two or three of the observations wells contained more than one-inch of product or if the three observation wells were not diverse enough in terms of transmissivity, a second round of test borings was required.

If the installation of the additional test boring locations failed to produce locations that met the selection criteria (i.e. less than one inch of product and diverse transmissivities), the two pumping test wells would be installed at those locations least affected by the free product, providing the possibility that one or both of the pumping test wells could be located in an area with free product greater than a few inches in total thickness. Under these circumstances, Geraghty & Miller would explain to the USEPA within 30 days of this determination how the effects of the presence of more than a few inches of product would impact the performance of the pumping test.

The Pilot Study Work Plan called for the performance of aquifer pumping tests at two separate recovery well locations. The recovery wells would be located at ***high*** and ***low*** transmissivity zones as determined by the monitoring well installation program. The Work Plan stipulated that aquifer step and 48-hour constant rate pumping tests would be conducted at each recovery well location. The two aquifer pumping tests were designed to provide a reliable range for the hydraulic conditions that can be expected for the full-scale system of recovery wells which is the proposed remedial alternative for intercepting oil and oil residuals that are migrating into the slough.

MONITORING AND RECOVERY WELL INSTALLATION

A total of 26 borings were completed during the test well installation and recovery well installation programs conducted during the months of June, July, and August 1995 as part of the Pilot Study Work Plan at the Sylvan Slough Project Site. The reasoning behind the installation of each of the wells is discussed later in this section. The 26 borings were completed as follows:

- two were completed as recovery wells in the upper fill unit (RW-1 and RW-2);

- one was completed as a recovery well in the lower sand and gravel unit (RW-3);

- nine were completed as monitoring wells in the upper fill unit (GM-20S, GM-22S, GM-23S, GM-24S, GM-25S, GM-26S, GM-27S, GM-28S, and GM-29S);

- ten were completed as monitoring wells in the lower sand and gravel unit (GM-19D, GM-20D, GM-22D, GM-23D, GM-24D, GM-25D, GM-26D, GM-27D, GM-28D, and GM-29D);

- one was completed as a monitoring well screened across both the upper and lower units (GM-21); and,

- two were completed as monitoring wells across both the upper and lower units during the initial boring installation phase (GM-20 and E-5) and subsequently abandoned since there existed a potential for cross-contamination due to the fact that the wells were screened across both the upper and lower units.

The wells were used to define the extent of free product and determine the hydrogeologic properties of the deposits underlying the site. Specific details related to each of the 26 soil boring/well location are shown on the soil boring/monitoring well construction logs provided in Appendix A.

Geraghty & Miller installed monitoring wells at the three initial test boring locations (W-5 and E-5) and between the location of the proposed line of recovery wells and the slough (GM-20) at the Sylvan Slough Project Site on June 8 and 9, 1995 consistent with the Pilot Study Work Plan. Except for the westernmost initial test well location (W-5), all of the monitoring wells contained in excess of 0.1 feet of free product. During the initial exploration activity, Geraghty & Miller was unable to delineate the extent of free product to the east and could not identify two acceptable recovery well locations using the selection criteria defined in the Pilot Study Work Plan (i.e., less than one-inch of free product and potentially diverse transmissivities). As a result and consistent with the Work Plan, Geraghty & Miller needed to return to the Sylvan Slough Project Site to install additional test wells to determine the eastern extent of free product and to identify potential recovery well locations.

The second phase of the test well installation program was performed on June 21 through 23, 1995. At the completion of the second test well installation event, Geraghty & Miller confirmed that the migration of oil into Sylvan Slough was not occurring solely due to the migration of oil on top of the water table. The initial conceptual model of the oil migration in the subsurface consisted of free product floating on the shallow water table within the unconsolidated fill deposits. During the initial and second phases of exploratory drilling at the Sylvan Slough Project Site, Geraghty & Miller observed that the fill deposits are underlain by a very firm to stiff silty clay that was identified as the former topsoil layer prior to the deposition of the foundry sand fill materials in the 1940s and 1950s. In the area adjacent to the slough, the silty clays are underlain by saturated sand and gravel.

While drilling, Geraghty & Miller observed at several of the initial test well (boring) locations (C-5, E-5, and GM-20) that the free product layer within the unconsolidated fill deposits was thin to absent; however, once the silty clay was penetrated, free product (diesel fuel) was encountered. Further drilling confirmed that the silty clay layer was trapping the free product below the unconsolidated fill and acting as a barrier to migration of the product on the shallow water table. The less dense diesel fuel could not rise to the water table surface in the overlying fill deposits and remained trapped atop the sand and gravel unit.

Based upon our observations, the silty clay appears to act as a local confining unit that inhibits groundwater flow between the saturated unconsolidated fill deposits and the underlying sand and gravel unit. Moving southward away from the slough, the sand and gravel thins until the silty clay directly overlies the shale bedrock, as observed during previous drilling activities performed at the IIR property. Geraghty & Miller suspects that areas exist where the silty clay is thin or absent, such as old erosional features or drainageways, and the sand and gravel unit is in direct contact with the saturated unconsolidated fill deposits allowing for hydraulic connection between the two units. The localized cross-connection of the sand and gravel and the fill deposits could account for the localized nature of observed hydrocarbons in the slough.

Due to concerns about monitoring wells screened across the fill deposits and the sand and gravel acting as conduits for oil being introduced into the unconsolidated fill deposits, Geraghty & Miller abandoned the two initial test wells (Test Wells GM-20 and E-5) during the second phase of well installation activities. Although it is screened across both units, Test Well W-5 (renamed GM-21) was not abandoned due to the fact that no free product was noted in either the fill deposits or the underlying sand and gravel unit. The abandoned test well locations (GM-20 and E-5) were replaced by two paired monitoring well locations with shallow wells screened in the fill above the confining layer (GM-20S and GM-23S) and deeper wells screened in the sand and gravel below the confining layer (GM-20D and GM-23D). In addition, paired monitoring wells, GM-22S and GM-22D, were installed at the location of the third initial test boring location (C-5) specified in the Pilot Study Work Plan. The locations of these newly installed monitoring wells are depicted on the monitoring well location map provided in Appendix B.

Since the eastern extent of free product in the lower sand and gravel unit was not delineated in the previous drilling phases, a third phase of the test well installation program was conducted on July 26, 27, 31 and August 1, 1995. To delineate the eastern extent of free product at the Sylvan Slough Project Site in the lower sand and gravel unit, one additional test well pair (GM-26S and GM-26D) was installed along with a well screened in the lower sand and gravel unit (GM-19D) located proximate to Monitoring Well GM-19 which was installed during a previous investigative phase and screened in the fill unit. The locations of the wells installed during the third installation phase are depicted on the monitoring well location map provided in Appendix B. Two soil borings were completed to the underlying bedrock during the third well installation phase to determine the thickness of the lower sand and gravel unit.

At the completion of the third phase of test well installation, Geraghty & Miller held a meeting with USEPA Region V and the United States Coast Guard (USCG) at the Sylvan Slough Project Site on August 1, 1995. During the meeting, Geraghty & Miller discussed the following:

- each phase of monitoring well installation;
- revised hydrogeological conceptual model of the migration of oil into the slough;
- location of the recovery wells; and,
- performance of aquifer pumping tests in the upper fill deposits and lower sand and gravel unit rather than at the locations exhibiting the highest and lowest transmissivities.

The discussions held during the August 1, 1995 meeting were summarized by Geraghty & Miller and forwarded to USEPA and USCG in a memorandum dated August 28, 1995 (Geraghty & Miller 1995c).

Subsequent to the meeting with USEPA and USCG, Geraghty & Miller installed three recovery wells, two screened across the upper fill unit (RW-1 and RW-2) and one screened across the lower sand and gravel unit (RW-3), to be used for the aquifer pumping tests. In addition to the three recovery wells, three additional paired monitoring well locations were installed proximate to the recovery wells (5, 15, and 30 feet away from the recovery wells) to be used to monitor aquifer performance during the aquifer pumping tests (GM-27S, GM-27D, GM-28S, GM-28D, GM-29S, and GM-29D. The recovery wells and additional monitoring well locations were installed on August 14 to 18, 1995. The locations are depicted on the monitoring well location map provided in Appendix B.

As a result the test well installation program and subsequent analysis of the field data, Geraghty & Miller concluded that the free product occurred as a thin, discontinuous layer in the upper fill deposits and as a thicker, more continuous layer trapped by the silty clay layer at the top of the sand and gravel unit. The hydrocarbons observed entering Sylvan Slough are believed to be caused by free product entering the upper fill deposits through the windows and thinnings in the silty clay layer from the underlying sand and gravel. The product then flows through the fill and discharges to the slough.

CONCEPTUAL MODEL OF HYDROGEOLOGIC CONDITIONS

The conceptual model of the hydrogeologic conditions encountered at the Sylvan Slough Project Site was further refined based upon field observations made by Geraghty & Miller during the monitoring and recovery well installation program.

LOCAL GEOLOGY

The conceptual model of the oil migration in the subsurface originally consisted of free product floating on the shallow water table within the fill and sand and gravel deposits underlain by bedrock. Based on the results of the monitoring and recovery well installation program of the aquifer pumping test pilot study, Geraghty & Miller has refined the conceptual model of the local site geological setting.

The borings completed during the monitoring and recovery well installation program located immediately adjacent to the slough demonstrate that the upper subsurface deposits consist of fine-to-medium grained sandy fill material containing limestone and sandstone pebbles and fragments of slag and metal. The upper fill unit is generally 19 to 21 feet thick across the Sylvan Slough Project Site immediately adjacent to the slough. The thickness of the upper fill unit decreases to the south to between 0.5 and 3.5 feet in the area south of the IIR property. To the north, approximately 20 feet north of the line of newly installed wells, the fill deposits end abruptly at the bank of the slough.

The lowermost three to four feet of the fill deposits are saturated immediately along the slough. The saturated thickness of the fill decreases towards the south before the unit becomes unsaturated beneath the IIR property. Thin, isolated patches of free product have been observed on the water table within the saturated fill deposits between Monitoring Wells GM-20S and GM-19S (Appendix B).

The upper fill deposits are underlain by a layer of stiff, silty clay. The clay is believed to be the former topsoil layer that formed the ground surface before being overlain by the foundry sand fill materials. Several of the borings drilled to the south of the Navistar property at the Sylvan Slough Project Site during the Initial and Phase II site investigations also encountered this unit reflecting its widespread distribution below the entire area. The silty clay layer ranged between 2 and 5 feet in thickness in the borings completed during the monitoring and recovery well installation program. However, Geraghty & Miller suspects that the silty clay layer is locally absent in some areas, producing holes or windows in the silty clay where the fill is in direct contact with the underlying sand or sand and gravel.

Elevation data show that the silty clay layer slopes gently towards the slough. The upper and lower surfaces of the clay layer are irregular reflecting the topography of the site prior to infilling. Free product has been observed coating the clay in many of the recently drilled boring locations. Additionally, free product was observed in the lower sand and gravel unit at thicknesses of greater than one foot at boring locations where no diesel was observed in the upper fill deposits. Specific examples include GM-20S and GM-25S.

The silty clay layer is underlain by coarse sand and gravel deposits containing trace to small amounts of silt. The gravel is well-rounded, consists of pebbles with variable composition, and exhibits a coarse-sand matrix that occasionally forms discrete layers. The site investigation data show that the sand and gravel unit is thickest close to the river and pinches out to the south. The unit was not detected in the borings completed near the former railroad passenger station on the south side of the IIR property. The sand and gravel is fully saturated in the area closest to the river.

Geraghty & Miller completed two borings to the base of the lower sand and gravel unit to determine its thickness. The boring completed to a total depth of 46 feet below land surface adjacent to Monitoring Well GM-21D encountered an overall thickness of 17 feet for the lower sand and gravel unit, while the second boring completed to a total depth of 56 feet below land surface adjacent to Monitoring Well GM-23D noted an overall thickness of 38 feet. Black, fissile shale (bedrock) was observed underlying the sand and gravel unit at both boring locations. The shale has also been encountered in borings completed on the BNR and IIR properties. No free product was noted in the bedrock at any of the current or previous boring locations.

Groundwater levels are above the top of the lower sand and gravel unit reflecting the confining effect of the overlying silty clay. The deposit is under unconfined conditions further to the south where it forms the shallowest saturated unit below much of the IIR property. Based upon our observations, the silty clay appears to act as a local confining unit that inhibits groundwater flow between the saturated unconsolidated fill deposits and the underlying sand and gravel unit. Moving southward away from the slough, the sand and gravel pinches out until the silty clay directly overlies the shale bedrock which was observed previously at the IIR property. Geraghty & Miller suspects that areas exist where the silty clay is thin or absent, such as old erosional features or drainageways, and the sand and gravel unit is in direct contact with the saturated fill deposits allowing for hydraulic connection between the two units. The localized cross-connection of the sand and gravel and the fill deposits could account for the localized nature of observed hydrocarbon release to the slough.

Free product, ranging in thickness from 1.0 to 3.0 feet, have been observed in the sand and gravel between GM-22D to the west and GM-25D to the east. The presence of free product in the lower sand and gravel unit is independent of its presence in the upper fill deposits. Product thicknesses are greatest in those areas where the elevation of the base of the silty clay layer is higher than its surroundings. The presence of free product in the highest part of the lower sand and gravel unit reflects the density difference between the free product and groundwater. The downward-sloping surface of the silty clay layer traps the free product below the clay and prevents it from discharging directly to the slough.

LOCAL HYDROGEOLOGY

A conceptual model of the local hydrogeology at the Sylvan Slough Project Site was developed using the geologic data gathered from boring logs (Appendix B), physical soil analyses, and slug testing. Grain-size analyses and slug tests showed that the soils associated with the upper fill deposits and lower sand and gravel unit are relatively permeable. A more detailed discussion is presented in the *Hydraulic Conductivity Testing* section of this report. The intervening silty clay layer is believed to less permeable.

Water-level measurements have been used to determine the groundwater flow regime underlying the Sylvan Slough Project Site. Water-level data show that groundwater flows from the south to the north in the upper fill deposits. Horizontal hydraulic gradients of between 1×10^{-2}

and $1x10^{-3}$ *feet per foot (ft/ft) have been measured in this unit.* Horizontal gradients become gentler approaching the slough, reflecting the increase in saturated thickness and transmissivity to the north. Horizontal hydraulic gradients in the lower sand and gravel unit of between $1x10^{-3}$ and $1x10^{-4}$ ft/ft have been observed along the slough. The lower gradient is believed to be a reflection of the higher hydraulic conductivity of the deeper unit.

Water-level differences of up to 2.5 feet have been noted between shallow and deep paired monitoring well locations. The static water-levels in the upper fill deposits are higher than those observed in the lower sand and gravel reflecting a downward hydraulic gradient between the two units. Based on vertical gradients, groundwater appears to flow from the upper fill deposits through the silty clay layer into the lower sand and gravel unit. However, free product was observed to flow upward from the lower unit to the upper fill unit, opposite of the vertical groundwater flow direction. The migration of free product from the lower sand and gravel unit to the water table in the fill is due to differences in product density between water and the diesel fuel product. As a result, it is believed that free product discharges to slough from the sand and gravel unit via the upper fill deposits and its related seepage faces along the bank of the slough. *Groundwater in the lower sand and gravel unit discharges directly to the slough.*

PUMPING TEST ANALYSIS

As amended in the August 1, 1995 meeting with the USEPA and USCG (Geraghty & Miller 1995c), Geraghty & Miller conducted aquifer pumping tests in the shallow water table unit above the confining clay layer and the lower sand and gravel at the Sylvan Slough Project Site. The Work Plan originally called for the groundwater pumping tests to be performed at the well locations exhibiting the highest and lowest transmissivities based on the original conceptual model for the hydrogeology of the site as it related to the migration of oil into the slough. The conceptual model of the oil discharging to the slough was revised to reflect the presence of a local confining layer that was trapping free product in the lower sand and gravel unit and allowing it to migrate into the shallow unit by thinnings or absence of the confining layer.

The principal objective of the two groundwater pumping tests was to determine the hydraulic conductivity of each respective unit. Secondary objectives included estimates of the vertical hydraulic conductivity of the intervening aquitard, the degree of hydraulic connection between the aquifer units and Sylvan Slough, the storage properties of the system, and the vertical anisotropy of the units. Anisotropy is the ratio of horizontal hydraulic conductivity to vertical hydraulic conductivity. These hydraulic properties would provide the design parameters necessary for any type of remedial system that may be installed at the Sylvan Slough Project Site to stop the discharge of oil into the slough.

HYDRAULIC CONDUCTIVITY TESTING

Prior to performing the tests, geologic borings, grain-size analyses, and slug tests were performed to obtain an initial estimate of the thickness and permeability of the shallow and deeper units as well as the intervening aquitard. The borings indicate that the average saturated thickness of the shallow water-bearing unit in the upper fill deposits is 3.5 feet, the average thickness of the aquitard is 3 feet, and the thickness of the lower sand and gravel unit is estimated at 34 feet. As described in the *Local Geology* section of this report, the lower sand and gravel unit is underlain by less permeable shale.

Grain-size analyses performed by CGC, Inc. of Madison, Wisconsin on selected soil samples collected during the on-site drilling activities show a clear distinction between the upper water-bearing unit and lower sand and gravel unit. The results of the grain-size analysis are summarized in Table 1 with complete copies of the data provided in Appendix C. The Hazen formula was applied to the distribution curves to estimate hydraulic conductivity. When the soil matrix of the sample was well-sorted, the more accurate Masch-Denny formula (Masch and Denny 1966) was applied to the distribution curves to estimate hydraulic conductivity. Based on the grain-size analyses, the coarse sand in the lower unit exhibit a hydraulic conductivity of several hundred feet per day (ft/day) while the finer sand (i.e., fill material) in the shallow unit exhibits a value that is lower by about one order of magnitude, consistent with the observed hydraulic gradients.

The same permeability contrast between the upper and lower units observed in the grain-size analyses was evident in the slug tests that were performed on select monitoring wells at the Sylvan Slough Project Site. The hydraulic conductivity values determined from the slug tests are summarized in Table 2. The range of hydraulic conductivity values, as determined from the slug test analysis, were 1.84×10^{-5} to 9.60×10^{-3} centimeters per second (cm/sec) or 0.05 to 27.0 ft/day for the shallow unit and 1.90×10^{-4} to 4.70×10^{-2} cm/sec or 0.50 to 133 ft/day for the lower sand and gravel unit.

Geraghty & Miller is cognizant of the fact that estimates of hydraulic conductivity values using grain-size analysis and slug tests are representative of only a small volume of the subject water-bearing unit. In a homogeneous deposit, the analysis of a small volume of the subject water-bearing unit may be sufficient to characterize the overall permeability of the unit. In heterogeneous deposits, preferential pathways may exist that are difficult to detect by grain-size analyses and slug testing, but enhance the overall permeability of the unit.

The shallow water-bearing unit consists primarily of fill materials and is expected to be fairly heterogeneous. The lower sand and gravel unit consists of alluvial material, including very coarse channel deposits. Based on the limits of the grain-size and slug testing methods, the hydraulic conductivity estimates presented above for the lower sand and gravel unit are expected to be biased low. It is also worth noting that the slug test results in both units will be biased low due to the low permeability "skin" around the borehole produced during drilling. The "skin" refers to the smearing of the borehole wall by the augers that occurs during drilling. Groundwater pumping tests overcome these biases since they sample a large volume of the water-bearing unit and the "skin" effect on drawdown results in observation wells is negligible.

SHALLOW PUMPING TEST

Monitoring Well GM-29S, which is screened across the saturated fill materials in the shallow water-bearing unit, was pumped for 10 hours on August 25, 1995 at a constant rate of 1.0 gallon per minute (gpm). During the test, transducers and data recorders were placed at the following well locations:

- GM-29D: a well screened in the lower sand and gravel unit located at a radial distance of 4 feet from the test well;
- RW-2: a well screened in the upper unit located at a radial distance of 5 feet from the test well; and,
- RW-3: a well screened in the upper unit located at a radial distance of 30 feet from the test well.

Wells RW-2 and RW-3 were originally installed to serve as pumping wells in the shallow unit. However, due to the limited recharge of RW-2 and RW-3 observed during well development, Geraghty & Miller determined that Monitoring Well GM-29S would be better suited to sustain a constant pumping rate in order to complete the pumping test in the shallow unit.

The drawdown curves generated during the pumping test analysis for the test well (GM-29S) and the three observation wells (GM-29D, RW-2, and RW-3) are provided in Appendix D. Monitoring Well GM-22S, which is located at a radial distance of approximately 320 feet from the test well and designated a background well, was also monitored. Monitoring Well GM-22S was unaffected by pumping.

The water levels in the pumping (test) well display "runaway" drawdown at the end of the test (Figure D-1). It is hypothesized that the upper part of the shallow unit is slightly more permeable than the lower part in the vicinity of GM-29S. Because the initial saturated thickness of the test well was 3.5 feet, the dewatering of the shallow water-bearing unit around the test well during the course of the test reduced the effective transmissivity to a point where it could no longer sustain pumping at 1.0 gpm after 10 hours.

The response of the pumping well to discharge cannot be used to calculate aquifer parameters since the drawdown was affected by well inefficiency. Moreover, examination of the log-log drawdown curve for RW-2 suggests that the response of this well is also inappropriate for analysis. The early straight-line segment of the drawdown curve for RW-2 (Figure D-2) opens the possibility that the drawdown pattern in this well is affected by casing storage in the pumped well. It is clear that the well screened in the lower sand and gravel unit located 4 feet from the pumping well, GM-29D, cannot be used to deduce the transmissivity of the shallow unit. The small response in this well suggests limited leakage between the upper and lower units, but the drawdown is so insignificant (less than 0.03 ft) that it could be due to background effects associated with barometric pressure or river stage changes. In any event, the drawdown curve for GM-29D (Figure D-3) is not useful to calculate shallow hydraulic conductivity.

The pattern of drawdown for RW-1 shown in Figure D-4 is typical of an unconfined aquifer. This well is located far enough away from the pumped well (30 feet) that it likely provides a indication of the average aquifer properties of the upper water-bearing unit. The widely used Neuman method for determining aquifer properties in the case of unconfined, anisotropic aquifers and partially penetrating wells was applied to the drawdown curve exhibited on Figure D-4. A computer model to implement the solution distributed by the United States Geological Survey (USGS) (Moench 1993) allowed the predicted response for assumed hydraulic parameters to be superimposed on the observed drawdown curve. The results shown on Figure D-4 include the following aquifer parameters and conditions:

- full penetration of the pumping well and observation well;
- horizontal hydraulic conductivity (K_h) = 20 ft/day (7.0×10^{-3} cm/sec);

- vertical hydraulic conductivity (K_v) = 1 ft/day ($3.5x10^{-4}$ cm/sec);
- saturated thickness = 3.5 feet;
- specific yield (S_y) = 0.1;
- pumping rate = 1.0 gpm; and,
- upward leakage through the aquitard is assumed negligible.

The fit of the drawdown curve for RW-1 that was achieved is excellent. The S_y value is reasonable for a short-term pumping test. The K_h value is within the range indicated by the grain-size analyses and, as expected, is at the high end of the slug test results due to the "skin-effect" bias. *The K_v value implies a vertical anisotropy (the ratio of K_h to K_v) of 20:1.* The goodness-of-fit is sensitive to all these parameters, including the vertical anisotropy. In summary, the results from RW-1 indicate that the shallow water-bearing unit acts as an unconfined aquifer with a hydraulic conductivity of 20 ft/day, which corresponds to a hydraulic conductivity value typically associated with a fine sand matrix.

DEEP PUMPING TEST

Recovery Well RW-3, which is screened across the lower sand and gravel unit, was pumped for 12 hours on September 5 and 6, 1995 at a constant rate of 75 gpm. Given the geometry of the lower sand and gravel unit, Geraghty & Miller expected the results of the pumping test in the lower unit to respond as a leaky, confined aquifer. The lower unit pumping test consisted of the following segments:

- An aquifer step test was performed on the lower sand and gravel unit which determined that the optimum pumping rate was between 75 and 100 gpm.

- Static water levels were measured for a period of 17 hours prior to the pumping test to assess the groundwater flow direction and determine the relationship between the elevation of surface water in the slough (i.e., river stage) to the water levels recorded in the lower unit.

- The lower unit was pumped for a period of 12 hours at a constant rate of 75 gpm while water levels were monitored in nearby wells.

- Static water levels were measured for a recovery period of 12 hours following the termination of pumping.

The river stage, using a staff gauge located 75 feet from the pumping well (RW-3), and barometric pressure, using a local barometer, were monitored every two hours during the test. A flow meter was used to verify that the discharge rate of 75 gpm was constant. The holding tanks used to contain discharge water were located approximately 700 feet west of the pumping well to avoid any potential impacts on the drawdown measurements from the accumulating weight of the contained water.

During the performance of the pumping test, Geraghty & Miller monitored water levels in wells with transducers/data loggers and manually. Water-level monitoring included wells screened in both the upper and lower units. The wells that were monitored during the pumping test consisted of GM-19S, GM-19D, GM-22S, GM-22D, GM-23D, GM-27S, GM-27D, GM-28S, GM-28D, GM-29S, and GM-29D. Monitoring Wells GM-23D and GM-29S were monitored manually while transducers and data loggers were used for the remaining wells that were monitored. The drawdown curves for the pumping (test) well (RW-3) and the nearby monitoring wells during the background, drawdown, and recovery periods are provided in Appendix E.

During the background period, the change in water levels was consistently upward in deep wells, which is equivalent to a decrease in drawdown. No discernible change was noted in the shallow well water levels. Examination of the drawdown curves for all the wells screened in the lower unit that were monitored during the background period, RW-3 (Figure E-1), GM-27D (Figure E-3), GM-28D (Figure E-5), GM-29D (Figure E-7), GM-22D (Figure E-10), and GM-19D (Figure E-12), shows a very strong agreement with the rising background trend. Well RW-3 is the pumping (test) well, GM-27D, GM-28D, and GM-29D are monitoring wells located within 40 feet of the test well (RW-3), and GM-22D and GM-19D are monitoring wells located 292 feet to the west and 857 feet to the east of the test well (RW-3), respectively. The pumping well and nearby observation wells (those located within 40 feet) showed a water-level rise of 0.25 feet during the background monitoring period, the distant observation wells (GM-22D and GM-19D) a rise of approximately 0.38 feet, and the slough a rise of nearly 0.40 feet.

The data clearly show that the lower unit is in connection with the slough and responds directly to a change in river stage (i.e., elevation of the surface of the water in the slough). It follows that the slough cuts down to a depth that is at least as deep as the upper part of the lower sand and gravel unit or the former topsoil layer ended at the old river bank. The efficiency of the transmission of the change in stage as a pressure wave to the observation wells implies that the river bed of the slough is not silted or the amplitude of the pressure wave would be blunted, and the hydraulic conductivity of the lower unit is high or the pressure wave would not rapidly propagate to the observation wells. A pressure wave is caused by fluctuations in the level of the river that impacts the lower sand and gravel unit by altering the confining pressure.

However, the drawdown curves in Appendix E also show that the drawup response noted at the beginning of the background period flattens and virtually disappears by the time the test started. This finding corresponds to the fact that the river stage stopped rising shortly before the test began and, during the active pumping (drawdown) and recovery periods, only fluctuated by several hundredths of a foot. Based on the fact that the fluctuation of the river stage was negligible during the drawdown and recovery periods, no correction was necessary to take account for changes in the river stage despite the good connection between the river and the aquifer.

The contrast between the change in water levels in the shallow and deep wells is significant. The drawdown curves for Wells GM-27S (Figure E-2), GM-28S (Figure E-4), and GM-22S (Figure E-9), which are screened in the upper fill unit, do not move with the river stage. The absence of a response does not necessarily mean that the slough is not connected to the shallow aquifer. The surveying results suggest that the slough intersects the unconsolidated fill material over a few feet. The absence of a response suggests that the hydraulic conductivity of the shallow unit is significantly lower than the deep unit and, as a result, is unable to readily convey the pressure wave. This conclusion was tested by comparing the quantitative results of the pumping tests of the shallow unit with the lower unit.

The background response of GM-19S is anomalous. Figure E-11 shows that it experienced a drawup similar in magnitude to the wells screened in the lower unit. However, there is a strong suspicion that because this well was installed before the stratified nature of the system was fully understood and may breach the aquitard and is open to the top of the lower sand and gravel unit. Therefore, GM-19S may be better classified in the context of the pumping test as a well screened in the lower unit.

The drawdown and recovery responses of the observation wells were analyzed to deduce the hydraulic parameters of the lower unit. Before describing the analysis, it is worth noting that no correction was needed to any of the drawdown or recovery data. As stated previously, the river stage was nearly constant once pumping was initiated. The barometer was constant to the nearest 0.01 feet of water during the drawdown test; it changed only 0.04 feet of water during the recovery period. While there is undoubtedly some noise in the data due to these and possibly other mechanisms, it is too small and too random to be subject to a reliable correction.

The well pairs at GM-19 and GM-22 were intended as background wells. The water levels at GM-19, located about 850 feet away from RW-3, are almost flat during the drawdown and recovery periods (Figures E-11 and E-12). This result is important due to the fact that it confirms the conclusion that no correction was needed to the data. The water levels at GM-22S are also flat (Figure E-9), indicating that the drawdown cone from RW-3 does not extend up into the upper fill unit at a distance of 283 feet away. However, there is a response in GM-22D, which is screened in the lower unit and is located adjacent to GM-22S (Figure E-10). GM-22D is unique in the fact that it suggests a continuing drawup pattern at the beginning of the test of about 0.04 feet over 2 hours. This trend is subsequently reversed as the pressure wave reaches the well inducing an apparent drawdown of 0.08 to 0.09 feet by the end of active pumping period. Unfortunately, during the recovery period, it was discovered that at some time during the test the cable holding the transducer had slipped, which may have artificially added to drawup. Because of this interference, it was decided to note that the cone of depression likely extends from RW-3 to GM-22D; however, given the drawdown magnitude is unclear, GM-22D will be excluded from the pumping test analysis.

The objective of the pumping test analysis was to deduce hydraulic parameters from the drawdown responses at GM-27S, GM-27D, GM-28S, GM-28D, GM-29D, and GM-23D located at radial distances of 5.3 feet, 5.7 feet, 15.9 feet, 20.3 feet, 36.9 feet, and 42.9 feet respectively, from the test well (RW-3). GM-29S and GM-23S which are screened in the upper fill unit were located too far from RW-3 to show any drawdown response; therefore, like the designated background wells GM-19S, GM-19D, and GM-22S, they were excluded from the pumping test analysis.

The pumping test analysis of the lower sand and gravel unit was performed using the computer model known as MODFLOW (McDonald and Harbaugh 1984). MODFLOW is a numerical model that uses a three-dimensional, finite-difference code. A groundwater model was used rather than the conventional leaky-type curve approach for confined aquifers because of the effect of the slough on the drawdown. Inspection of the drawdown curves indicates that the presence of the slough curtailed the response to pumping and led to a "premature" flattening of the drawdown curves. This boundary effect cannot be easily accommodated by the type-curve method. A MODFLOW model can explicitly incorporate the effect of the slough as well as the presence of the aquitard, the shallow aquifer, the vertical anisotropy within each unit, and the partial penetration of the pumping well. The results of the MODFLOW model are provided in Appendix F.

The model was constructed with four layers and a non-uniform spacing of rows and columns as shown on Figure F-1. For purposes of modeling, the lower unit was divided into two layers in order to incorporate the partial penetration of the deep well. The observation wells screened in the lower unit are all screened at elevations that correspond to the top of the third layer. In plan view, the model consists of 51 columns, numbered from south to north, and 43 rows, numbered from west to east. The node at column 26, row 18, used to simulate the location of the pumping well, has column and row dimensions of 0.5 feet by 0.5 feet. A ratio of 1.4 was used to expand the column and row dimensions to each side (i.e., columns 25 and 27 have widths of 0.7 feet, rows 17 and 19 also have widths of 0.7 ft, etc.). The entire grid extends 15,746 feet in the north-south direction and 8,405 feet in the east-west direction. These dimensions are large enough to remove all boundary effects on model calculations except that of the nearby slough.

Figure F-2 shows the section of the grid located within several hundred feet of the pumping well, RW-3, the location of the holding tanks relative to the monitoring wells, and the location of the slough. The model cells intersected by the east bank of the slough are treated as constant-head cells in layers 1, 2 and 3 of the model. The use of a constant-head condition implies no extra head loss through the slough bed, an assumption justified by the pronounced response of the deep wells to changes in slough stage. Figure F-3 depicts a magnified view of the grid in the vicinity of the pumping well (RW-3), and the location of the observation wells used in the pumping test analysis relative to the grid spacing.

Model inputs consists of distinct K_h and K_v values for the upper fill unit (layer 1), the aquitard (layer 2), and the lower sand and gravel unit (layers 3 and 4). The model results are also sensitive to the S_y value assigned to layer 1 and the storage coefficients assigned to layers 3 and 4.

The strategy used in "calibrating" the model was to fit as well as possible, at as many well locations as possible, the drawdown observed near the end of the active pumping period by selecting an appropriate horizontal and vertical hydraulic conductivity in the lower sand and gravel unit. For this purpose, arithmetic plots of drawdown versus time were used (see Figure F-4 for an example). Subsequently, the other parameters were calibrated by inspecting the early part of the curve through the use of semi-log plots (see Figure F-5 for an example). A difficulty immediately encountered was that the drawdown registered at the deep well located approximately 5 feet from the pumping well, GM-27D, is less than the drawdown registered at the deep well located approximately 15 feet from the pumping well, GM-28D. This anomaly immediately suggests that the lower unit is heterogeneous. The alteration of very coarse axial (or channel lag) deposits with somewhat finer channel or overbank deposits in the three-dimensional alluvial package is what likely accounts for the anomaly in drawdown. It is likely that GM-27D is located in a less permeable section of the lower unit than GM-28D and that the drawdown cone seeks the more permeable section of the unit causing greater drawdown at GM-28D. This result is well established for heterogeneous aquifers in contrast to the case for homogeneous aquifers where more drawdown indicates lower transmissivity.

During the calibration process, it was found that a model fit appropriate for GM-28D provided adequate fit for the other wells, with the exception of GM-27D; by contrast, a good fit with GM-27D causes a poor fit with all the other well locations. Based on these findings, it was decided that the estimated hydraulic conductivity value of the lower unit matching the drawdown and recovery observed at GM-28D was more representative of the overall conditions of the lower sand and gravel unit.

Figure F-6 shows that the fit for late-time drawdown at GM-28D is acceptable using a K_h value of 450 ft/day (1.6×10^{-1} cm/sec) and a K_v value of 90 ft/day (3.2×10^{-2} cm/sec). Figures F-7 and F-8 show that this same value provides an acceptable fit for GM-29D and GM-23D, respectively. As expected, the fit for GM-27D in Figure F-4 is not acceptable.

In the model, a K_h value of 20 ft/day, a K_v value of 1.0 ft/day, and a S_y of value of 0.1 were assumed for the upper fill unit based on the results of the shallow unit pumping test. The remaining parameters that needed to be quantified were the K_v of the aquitard and the storage coefficient of the lower unit. It should be noted that the model is sensitive to these parameters, but nearly completely insensitive to two other model inputs, the K_h and storage coefficient of the aquitard. It was possible to estimate the storage coefficient of the lower unit by matching the observed and simulated drawdown and recovery on a semi-log plot giving greater weight to the early time data. Again, GM-28D was used as the standard. Figure F-9 indicates that an acceptable match is achieved for this well when the storage coefficient of the deep aquifer is set to 0.02. The match in Figure F-10 for GM-29D is acceptable. Data are lacking for GM-23D (Figure F-11) and, as expected, the match is poor for GM-27D (Figure F-5).

The value of 0.02 for the confined storage coefficient is high, but not expected if the water table drops into the lower unit or if there are windows in the aquitard. The lower unit is unconfined at a distance of several hundred feet to the south of the pumping well, likely too far away to impact the pumping test. It seems more likely that the lower sand and gravel unit is taking advantage of some release of water through the draining of pores in the vicinity of the windows in the aquitard or through connection to the slough. However, the large head difference shown in the water table and potentiometric maps for the upper and lower units suggests that these windows must be narrow.

An effort was made to estimate the K_v of the aquitard by adjusting its value in the model to simulate the drawdown observed in the shallow wells GM-27S and GM-28S (Figures F-12 and F-13). Because the drawdown in these wells was on the order of 0.02 to 0.03 feet, it was difficult to separate noise from true drawdown. However, the model best reproduced these levels with a K_v value of 0.03 ft/day (1.0×10^{-5} cm/sec). This hydraulic conductivity is appropriate for a clayey silt and implies that the unit will allow relatively little leakage between the upper and lower units.

The analysis of the pumping test conducted in the lower sand and gravel unit produced the following hydraulic parameters:

K_h (shallow) = 20 ft/day;

K_h (deep) = 450 ft/day;

K_v (shallow) = 1.0 ft/day;

K_v (deep) = 90 ft/day;

K_v (aquitard) = 0.03 ft/day;

S_y = 0.1; and,

Storage coefficient (deep) = 0.02.

The hydraulic conductivity value for the lower sand and gravel unit is appropriate for a coarse sand and likely reflects the importance of channel deposits in the makeup of the system.

CONCLUSIONS

Based on the data collected during this investigation, Geraghty & Miller has made the following conclusions:

- The shallow-most unconsolidated materials in the northern portion of the Sylvan Slough Project Site adjacent to the slough consist of an approximately 20-foot thick layer of fine-to-medium grained sandy, unconsolidated fill material containing fragments of slag and metal. Approximately 3.5 feet of the unconsolidated fill is saturated.

- The unconsolidated fill is underlain by a 2-to-5 foot thick layer of silty clay which acts as a local confining layer to the lower sand and gravel unit.

- The lower sand and gravel unit, which is underlain by shale, was observed to range in thickness from 17 to 38 feet adjacent to the slough.

- Hydraulic connections are believed to exist between the upper fill deposits and the lower sand and gravel deposits through windows or thinnings of the confining silty clay layer.

- The majority of the free product observed during the monitoring and recovery well installation was found in the lower sand and gravel unit.

- There is a downward vertical gradient from the unconsolidated fill to the lower sand and gravel unit, while free product leaks vertically upward from the lower sand and gravel unit through the "windows" in the confining layer.

- The unconsolidated fill unit groundwater pumping test performed at a constant rate of 1.0 gpm for a period of 10 hours showed the effects of pumping at a distance of 30 feet from the test well.

- A monitoring well screened in the lower sand and gravel unit located 4 feet from the upper unit test well showed an insignificant drawdown (0.03 feet) in response to pumping in the unconsolidated fill indicating the potential for limited leakage between the unconsolidated fill and lower sand and gravel unit. However, the limited drawdown may have been caused by background effects associated with barometric pressure or river level changes, rather than leakage between units.

- The unconsolidated fill acts as an unconfined aquifer with a hydraulic conductivity of 20 ft/day and is not strongly influenced by changes in the water level in the slough.

- The lower sand and gravel unit groundwater pumping test performed at a constant rate of 75 gpm for a period of 12 hours showed that the lower unit is in connection with the slough and responds directly to a change in river stage (i.e., elevation of the water surface of the slough).

- The heterogeneity of the lower sand and gravel unit is shown by the drawdown observed in the water level in monitoring wells screened in the lower sand and gravel unit. The observed drawdown in the water level at GM-28D, located 15 feet away from the test well, was greater than the drawdown observed in the water level at GM-27D, located 5 feet away from the test well.

- The storage coefficient of 0.02 for the lower sand and gravel unit is considered to be high and may be affected by the release of water due to the draining of pores in the vicinity of the "windows" in the silty clay confining layer, or through connection to the slough. However, the head difference between the water table map for the unconsolidated fill and the potentiometric map for the lower sand and gravel unit, respectively, suggests that the "windows" must be narrow.

- The pumping test results indicate that the proposed line of recovery wells adjacent to the slough would be a feasible remedial technology to mitigate the discharge of oil into the slough. The recovery well system conceptual design will be revised to address the findings of the pumping tests. However, based on the findings of the pumping tests, Geraghty & Miller will also evaluate alternate remedial technologies within the timeframe of the overall project schedule.

TABLES

Table 1. Hydraulic Conductivity Estimation from Grain-Size Distribution, Sylvan Slough Project Site, Rock Island, Illinois.

Boring/Depth Class/Unit	d10 mm	K (Hazen) cm/sec ft/day	d50 mm	d95 mm	d5 mm	d85 mm	d15 mm	K (Masch-Denny) cm/sec ft/day
GM-21/13-15 ft bls SP-SM/Upper	0.0757	0.0057 16	0.32	4.50	0.007	0.80	0.165	0.004 11
GM-21/17-19 ft bls SP-SM/Upper	0.1321	0.017 48						NA
GM-21/18-25 ft bls ML/Aquitard	< 0.0015	NA						NA
GM-22/12-14 ft bls SP-SM/Upper	0.1279	0.0016 46						NA
GM-22/16-18 ft bls SP-SM/Upper	0.0999	0.010 28	0.28	0.80	0.020	0.52	0.16	0.009 26
GM-22/22-24 ft bls SP/Lower	0.2198	0.048 137						NA
GM-23D/34-36 ft bls SP/Lower	0.3648	0.130 377	0.65	1.30	0.24	1.05	0.419	0.050 142
GM-23D/36-38 ft bls GW/Lower	0.3972	0.160 447						NA
GM-23D/38-40 ft bls GP/Lower	0.3319	0.110 312						NA
GM-23D/40-42 ft bls SP-SM/Lower	0.1637	0.027 76						NA
GM-23D/49-51 ft bls GP-GM/Lower	0.2848	0.081 230						NA

Summary of Results

Unit	*Range (ft/day)*	*Average (ft/day)*
Upper	11 to 48	34
Lower	76 to 447	263

Notes:

1. K denotes the hydraulic conductivity value which is expressed in centimeters per second (cm/sec) and feet per day (ft/day).
2. Calculation of K in cm/sec using the Hazen formula: K = 1.0xd10xd10 (in mm) is applicable when d10 is greater than 0.1 mm and less than 3.0 mm.
3. Calculation of K using the Masch and Denny reference is applicable only when the grain-size spread is small.

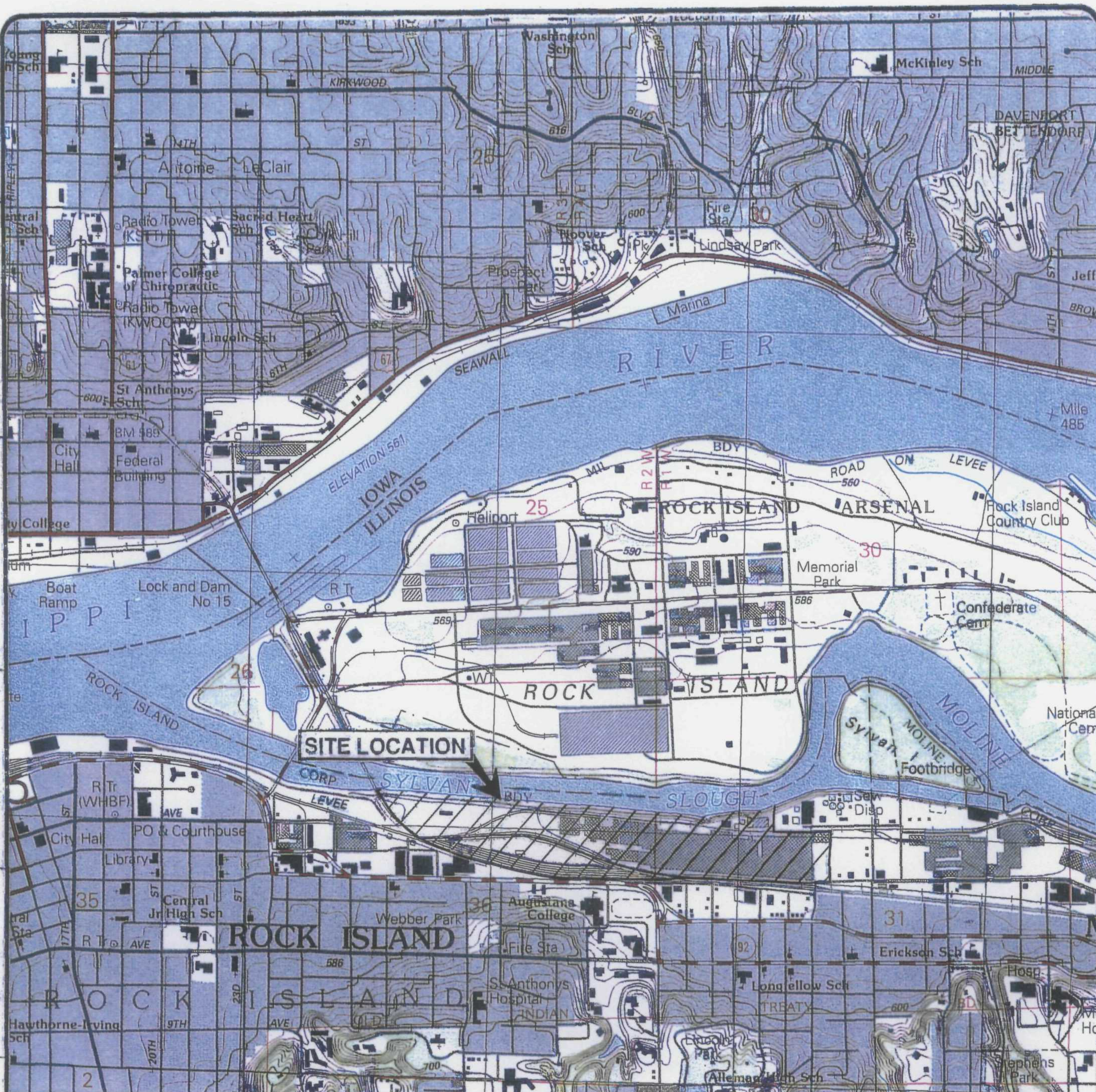
Table 2. Hydraulic Conductivity Estimation from Slug Test Results, Sylvan Slough Project Site, Rock Island, Illinois.

Monitoring Well Identification	K, Hydraulic Conductivity (cm/sec)
GM-20S (in) GM-20S (out)	7.73E-03 4.91E-04
GM-20D (in) GM-20D (out)	8.99E-02 4.79E-03
GM-22S (in) GM-22S (out)	2.10E-04 2.67E-04
GM-23S (in) GM-23S (out)	1.87E-05 1.80E-05
GM-24D (in) GM-24D (out)	1.64E-03 1.43E-03
GM-25S (in) GM-25S (out)	2.97E-03 1.62E-02
GM-25D (in) GM-25D (out)	2.40E-04 1.45E-04

Notes:

1. At each well location, "in" refers to the hydraulic conductivity measurement taken as the slug was placed into the well and "out" refers to the hydraulic conductivity measurement taken as the slug was pulled out of the well.

FIGURES



SOURCE: USGS 7.5 Minute Topographic Map, DAVENPORT EAST, IOWA-ILL. Quadrangle, 1991

N

0 1000 2000 4000

SCALE IN FEET

GERAGHTY & MILLER, INC.
Environmental Services

SITE LOCATION MAP

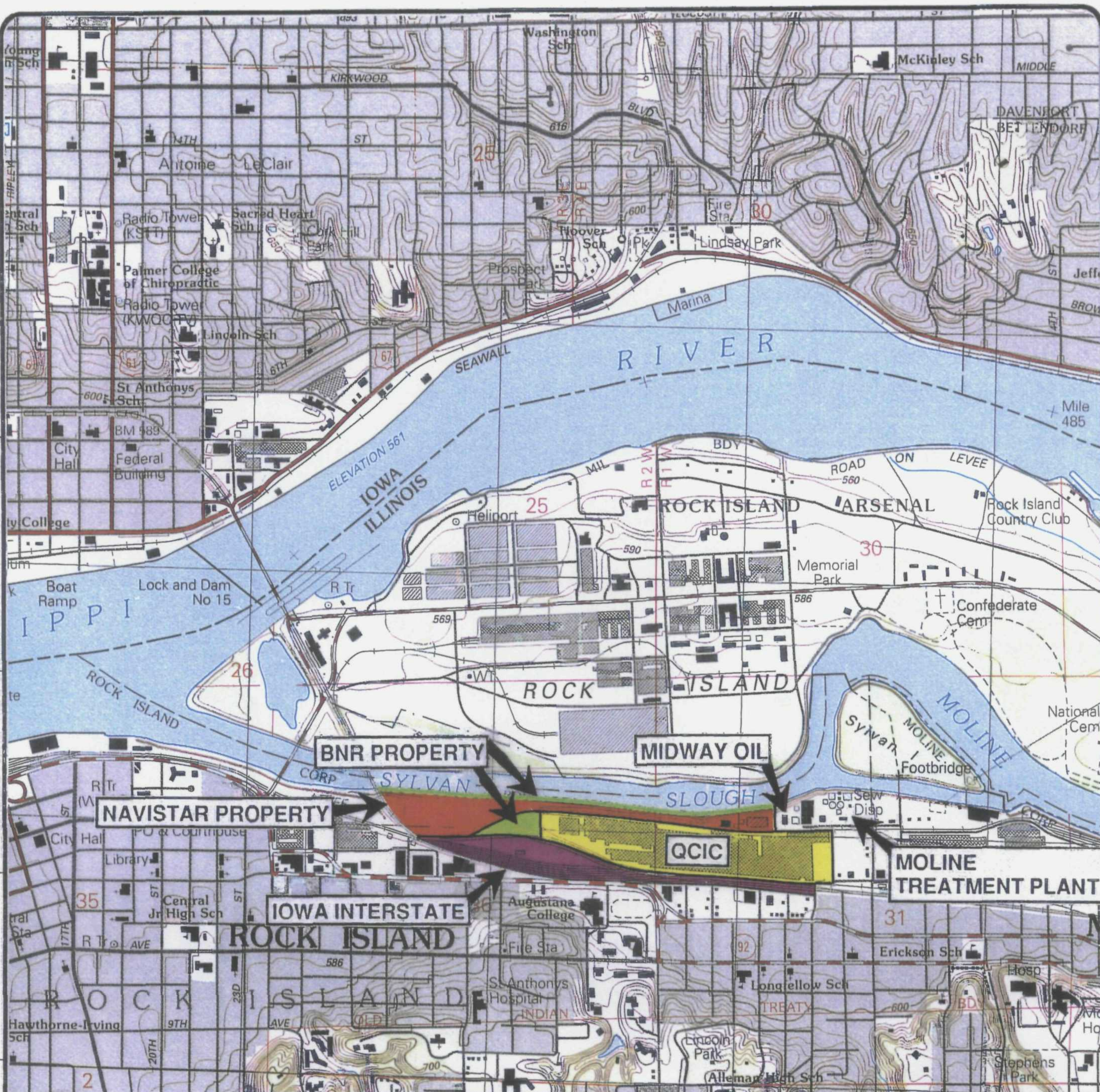
SYLVAN SLOUGH PROJECT SITE
ROCK ISLAND, ILLINOIS

FIGURE

1

DRAFTER: ELS
APPROVED:
CHECKED: MMM
DRAWING: 01
FILE NO.: 1343
PRJCT NO.: CI0299.002
DWG DATE: 01JUN94

DRAFTER: ELS
APPROVED:
CHECKED: MMM
DRAWING: 01
FILE NO.: 1343
PRJCT NO.: CI0299.002
DWG DATE: 01JUN94



SOURCE: USGS 7.5 Minute Topographic Map, DAVENPORT EAST, IOWA-ILL. Quadrangle, 1991

N

0 1000 2000 4000

SCALE IN FEET

GERAGHTY & MILLER, INC.
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PROPERTY OWNERSHIP LAYOUT

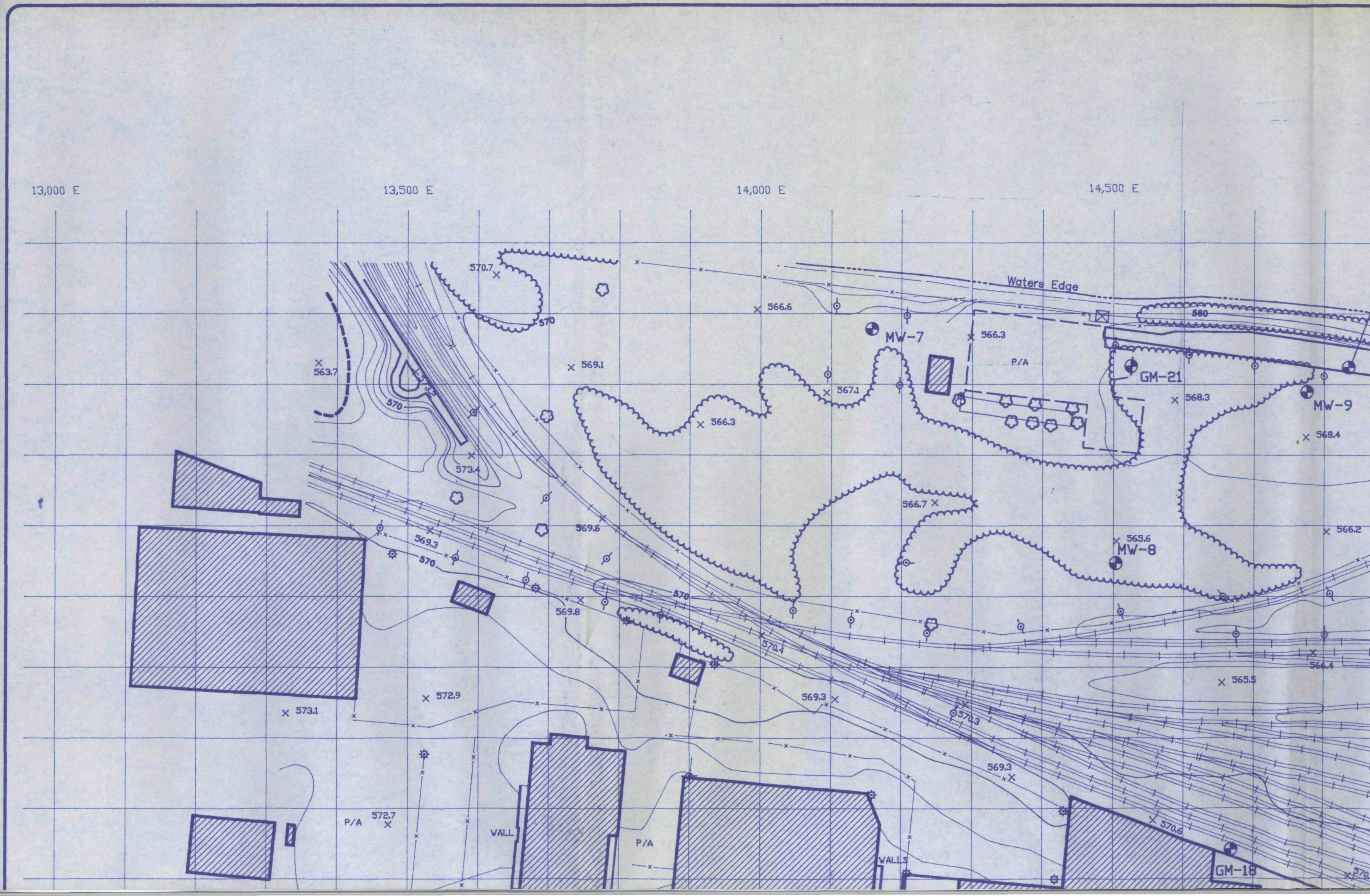
SYLVAN SLOUGH PROJECT SITE
ROCK ISLAND, ILLINOIS

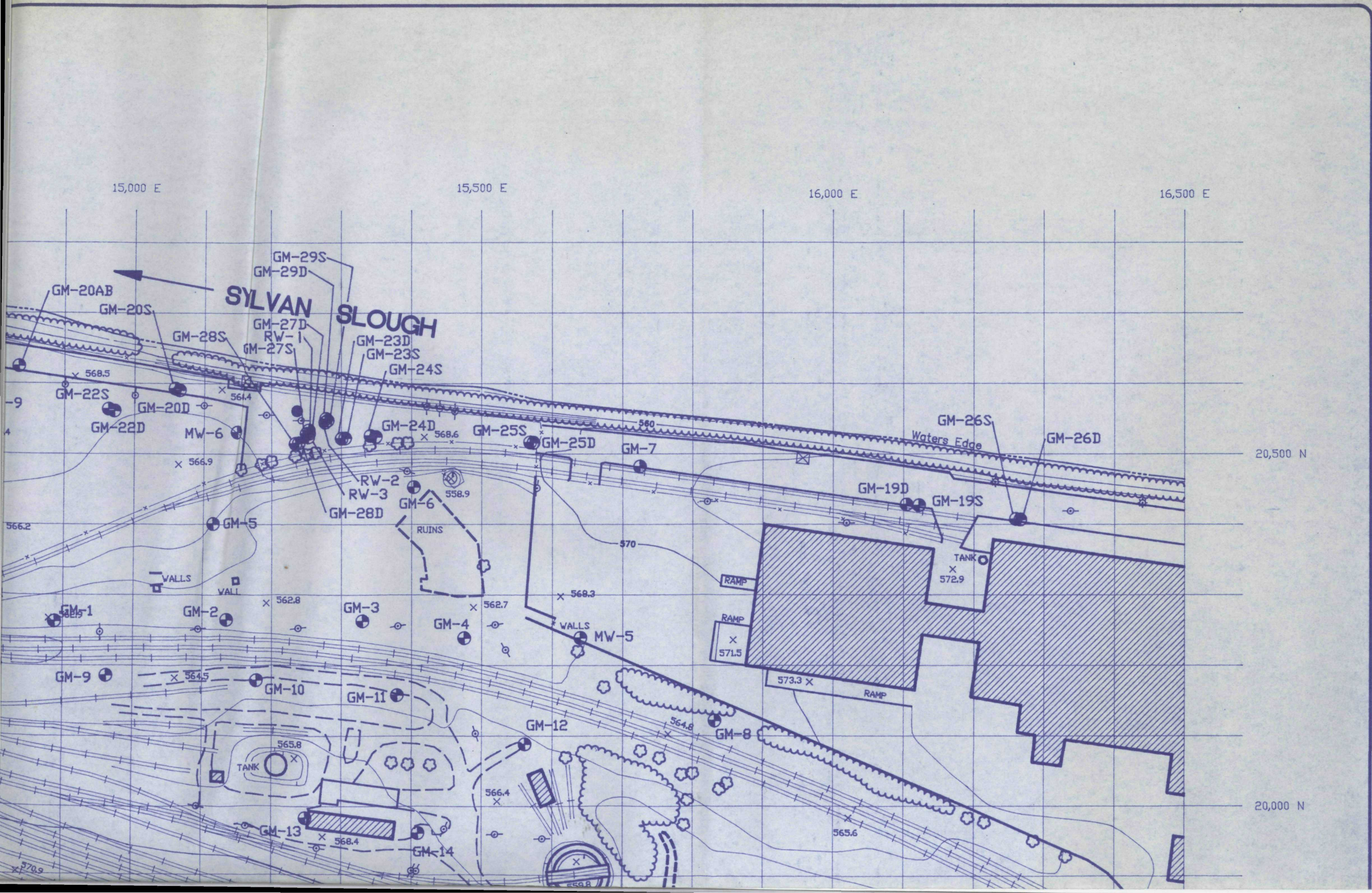
FIGURE

2

APPENDIX A

Well Location Map


13,000 E
13,500 E
14,000 E
14,500 E
Waters Edge
570.7
570
566.6
MW-7
566.3
P/A
GM-21
568.3
MW-9
568.4
563.7
569.1
567.1
566.3
573.4
566.7
569.6
569.3
570
565.6
MW-8
566.2
570
569.8
570.4
566.4
565.5
572.9
573.1
569.3
570.3
569.3
P/A
572.7
WALL
P/A
WALLS
570.6
GM-18


15,000 E
15,500 E
16,000 E
16,500 E
20,500 N
20,000 N
SYLVAN SLOUGH
GM-20AB
GM-20S
GM-28S
GM-29S
GM-29D
GM-27D
RW-1
GM-27S
GM-23D
GM-23S
GM-24S
GM-22S
GM-20D
GM-22D
MW-6
GM-24D
GM-25S
GM-25D
GM-7
Waters Edge
GM-26S
GM-26D
GM-19D
GM-19S
RW-2
RW-3
GM-28D
GM-6
GM-5
RUINS
570
560
TANK
572.9
RAMP
WALLS
WALL
GM-1
GM-2
GM-3
GM-4
MW-5
571.5
573.3
GM-9
GM-10
GM-11
GM-12
GM-8
GM-13
GM-14
568.5
561.4
566.9
568.6
558.9
566.2
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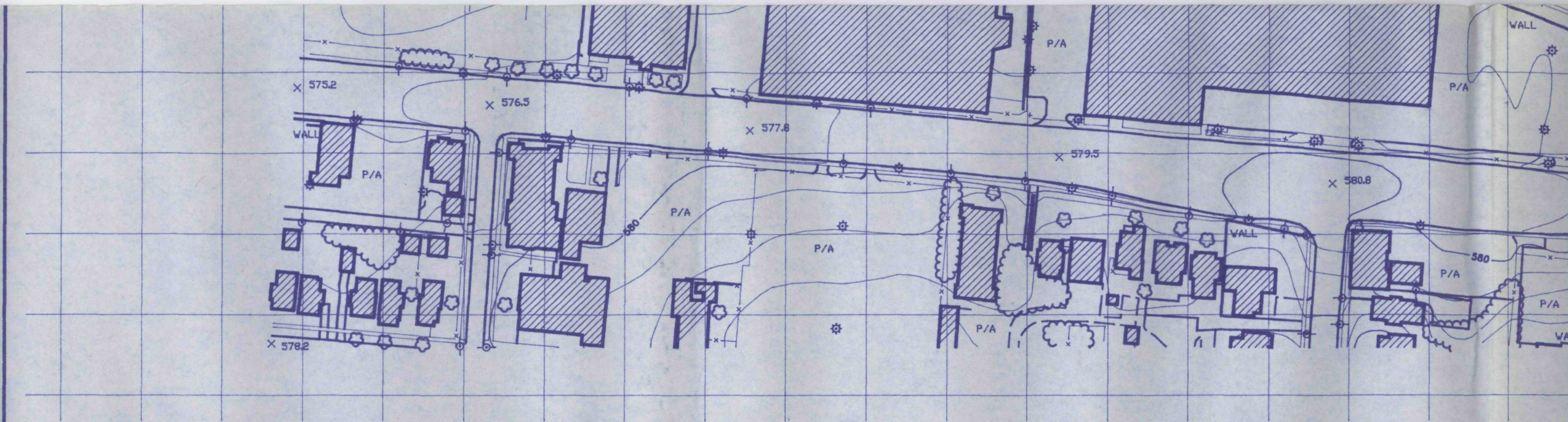
559.8



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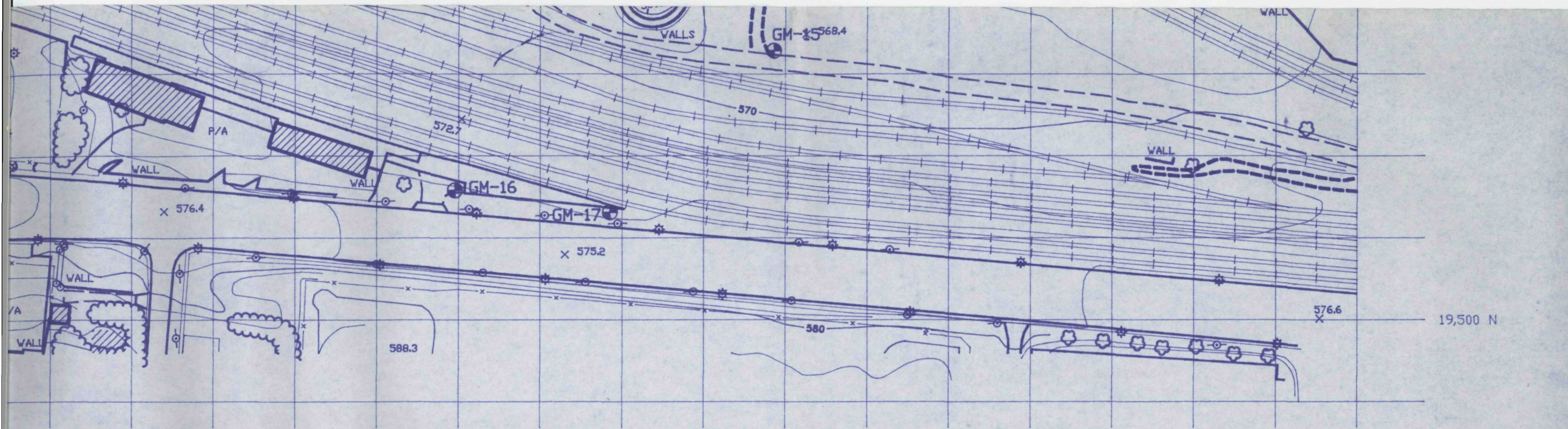
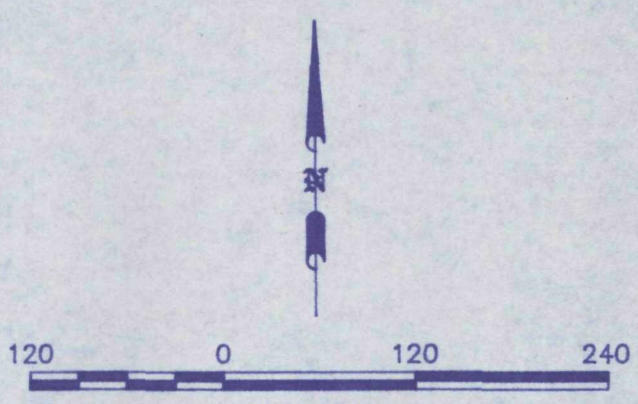
SCALE VERIFICATION
THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING:
USE TO VERIFY FIGURE REPRODUCTION SCALE

REV. NO.	DATE	



LEGEND

- MONITORING WELL/NUMBER
- STAFF GAUGE
- FENCE
- RAILROAD TRACKS
- EXISTING STRUCTURE/BUILDING
- 576.4 SPOT ELEVATION AT GRADE
- 580 EXISTING GRADE CONTOUR
- UTILITY POLE
- P/A PAVED AREA
- TREE
- TREE LINE
- WATERS EDGE



SOURCE: ABRAM AERIAL SURVEY CORPORATION, LANSING MICHIGAN, ABRAMS CONTRACT A.A.S.C. #25637. DATE OF PHOTOGRAPHY JULY 26, 1994. GRADE CONTOUR INTERVAL = 2'.

HORIZONTAL CONTROL GRID SITE SPECIFIC, SITE ELEVATIONS BASED ON U.S.G.S. ELEVATIONS.

DESCRIPTION	BY	APPR.		
			PROJECT NO.: C10299.004	FILE NO: NAVWLOC.DWG
			DRAWING NO.: C129904-DFIG	PLOT SCALE:1=120
			DRAFTED BY: S GOZNER	DATE: SEPT. 14, 1995
			CHECKED BY:	DATE:
			APPROVED BY:	DATE:
			LAST REVISION BY: S GOZNER	DATE: SEPT. 17, 1995

MONITORING WELL LOCATION MAP

NAVISTAR/BNR/IIR SITE
ROCK ISLAND, ILLINOIS

FIGURE

APPENDIX B

Boring/Well Construction Logs

MONITORING WELL GM-19S

Navistar/BNR
Rock Island, Illinois

Project No.: CI0299.004
Logged by: Laura Craven
Drilling Co.: Rock & Soil
Driller: Ron House

Date Drilled: July 11 & 12, 1994
Drilling Method: 4 1/4" dia. hollow stem auger
Sampling Method: Split-Spoon
Surface Elev.: NA
Measuring Pt. Elev.: NA

Depth (feet)	PID (in ppm)	Blows/6-in.	Samples	Graphic Log	Soil Class
	0.0	13-38-50			CONC / FILL
	0.0	21-115			FILL
5	0.0	14-16-18-13			FILL
	0.0	10-17-19-15			FILL
	0.2	10-20-18-18			FILL
10	0.0	10-13-15-16			SP
	0.0	47-29-21-21			SP
15	0.0	10-15-13-15			SP
	0.0	12-24-20-27			SP
	0.0	8-17-19-20			SP
20	0.0	8-9-8-15			SP
	11.0	7-7-7-8			SP
25	75.0	2-3-6-8			CL
	15.0				CL
30					

GENERALIZED DESCRIPTION

CONCRETE

FILL: gravel, base coarse material, fine concrete powder

Dark brown, moist fine sand material at 1.75 to 2 feet

Gravel, base coarse fill at 2 to 2.4 feet

Black, moist, fine sand, loose at 2.4 to 5.5 feet

Rust, tan and black sand at 5.5 to 6 feet

Black, with litte rust, moist, fine sand, trace fine to coarse gravel and slat at 6 to 10 feet

SAND: black, moist, fine, trace coarse gravel and slag, few rust spots at 10 to 12.5 feet

Black, fine sand to coarse gravel-sized slag and coal, dry at 12.5 to 12.7 feet

Tan and black at 13.5 to 22 feet

3" cobble, fused sand and slag, light gray rock at 16.8 to 17.1 feet

Water table at 20.5 feet

Black, saturated, fine sand, medium dense, hydrocarbon-like odor at 22 to 25.4 feet

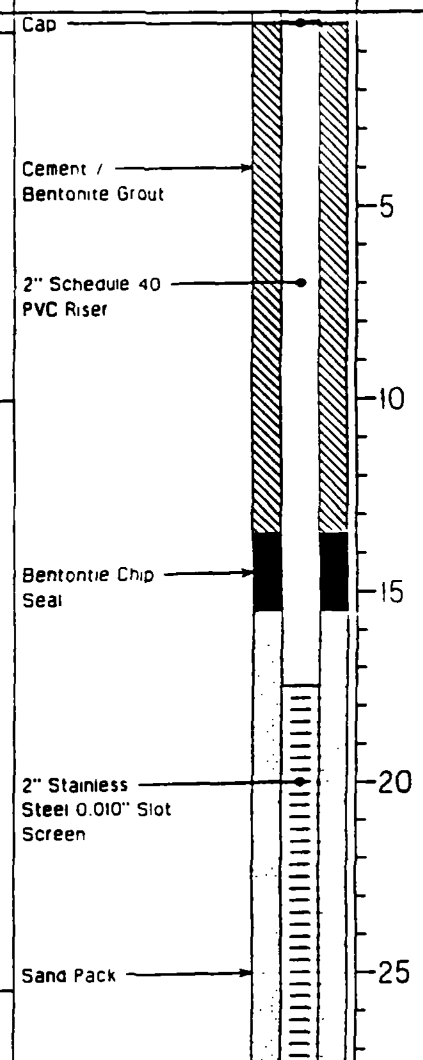
CLAY: gray, wet, stiff, some silt

Gray, moist to wet, stiff, some silt, trace roots, black staining, hydrocarbon-like odor, sheen observed; sand heaving into augers, also wire and wood caught in bit at 26 to 27.5 feet

Gray, saturated, fine to coarse gravel, subangular, to rounded, sheen at 27.3 to 27.5 feet

End of Boring at 27.5 Feet

WELL DIAGRAM



MONITORING WELL GM-19D

Soil Investigation
Rock Island, Illinois

Project No.: CI0299.006
Logged by: Ray Flynn
Drilling Co.: Rock and Soil
Driller: Dusty Jackson

Date Drilled: July 31, 1995
Drilling Method: 8-inch dia. hollow stem
Sampling Method: 2-inch dia. split spoon
Surface Elev.: 572.24
Measuring Pt. Elev.: 571.85

Depth (feet)	Blows/ft.	OVM (ppm)	Soil Class
	51	0.0	FILL
	136	0.0	
5	34	0.0	
	36	0.0	
	38	0.2	
10	28	0.0	SP
	50	0.0	
15	28	0.0	
	44	0.0	
20	36	0.0	
	17	0.0	
	5	78.5	CL
25	8	120.5	
	16	89.5	GP
30	36	79.5	
	30	35.9	
35			

GENERALIZED DESCRIPTION

CONCRETE, cored.

Gravel FILL, base coarse material, fine concrete powder.

At 1.75 to 2 ft, dark brown, moist, fine sand.

At 2 to 2.4 ft, gravel, base, coarse fill.

At 2.4 to 5.5 ft, black, moist, fine, sand.

At 5.5 to 6 ft, rust, tan and black sand.

From 6 to 10 ft, black, with little rust, moist, fine sand, trace fine to coarse gravel and slag.

Black, moist, fine SAND with trace, coarse gravel and slag, few rust spots at 10 to 12.5 ft.

At 12.5 to 12.7 ft, black, fine sand to coarse gravel-sized slag and coal, dry.

At 13.5 to 22 ft, tan and black sand.

At 16.8 to 17.1 ft, 3" cobble, fused sand and slag, light gray rock.

Water table at 20.5 ft.

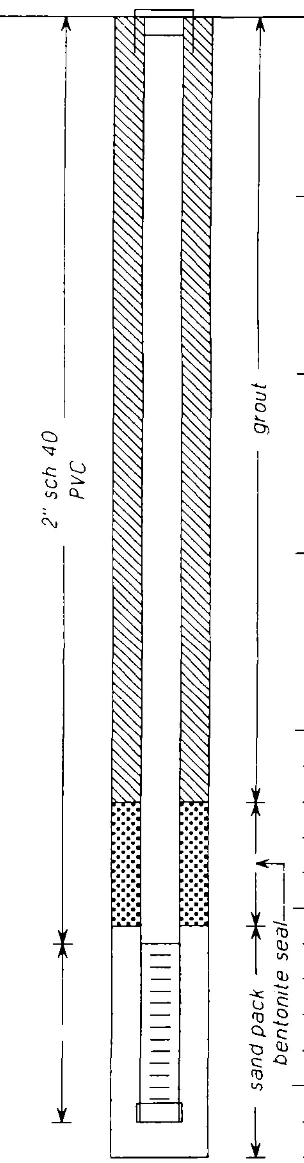
0.7' medium grained, black, loose, saturated sand with damp, olive- green, silty CLAY, stiff with hydrocarbon odor.

Coarse, loose, saturated GRAVEL, well-rounded, variable composition fragements. 40% coarse to medium green-gray sand matrix.

Very sandy GRAVEL, as above, with approximately 45% gray-green medium sand matrix. At 31.5 to 32 ft, fine to medium green-gray, loose to saturated sand.

End of Boring at 32 Feet.

WELL DIAGRAM



MONITORING WELL GM-20S

Soil Investigation
Rock Island, Illinois

Project No.: CI0299.006
Logged by: Ray Flynn
Drilling Co.: Rock and Soil
Driller: Dusty Jackson

Date Drilled: June 21, 1995
Drilling Method: 8-inch dia. hollow stem
Sampling Method: 2-inch dia. split spoon
Surface Elev.: 568.12
Measuring Pt. Elev.: 567.81

Depth (feet)	Blows/ft.	OVM (ppm)	Samples	Graphic Log	Soil Class
					SP
	22	12.6			
	26	7.6			
5					
	23	15.3			
	37	62.0			
10	12	66.9			
	25	31.5			
					GP
	40	67.7			
15					
	5	96.0			
					CL
	8	95.3			
					SP
20	25	125.0			
	17	136.0			
	10	75.9			
25					
30					

GENERALIZED DESCRIPTION

CONCRETE.

Dry, loose, uniform, dark-brown, medium SAND with 5% orange patches.

Slightly firm SAND with loose, coarse, pale-brown glass, dry.

Black, medium, uniform SAND, slightly firm to dry, occasional dark brown patches.

At 7-9 feet, angular to subangular gravel fragments up to 1 cm in diameter, loose.

At 10 feet, 0.3' gray-brown, slightly firm, silty SAND layer.

At 13 feet, 0.3' saturated, loose concrete and slag GRAVEL.

3" spoon. Slag GRAVEL with coarse angular black sand, loose, saturated, containing 5% well-rounded quartz pebbles. Slag fragments up to 0.2' in diameter.

Saturated GRAVEL with abundant rounded pebbles (variable composition) on 10" of loose, saturated, black, medium SAND, strong odor.

Damp, olive-green CLAY with diesel coating.

Coarse, medium, green SAND and 40% gravel matrix, product-saturated, well-rounded gravel fragments of variable composition, loose.

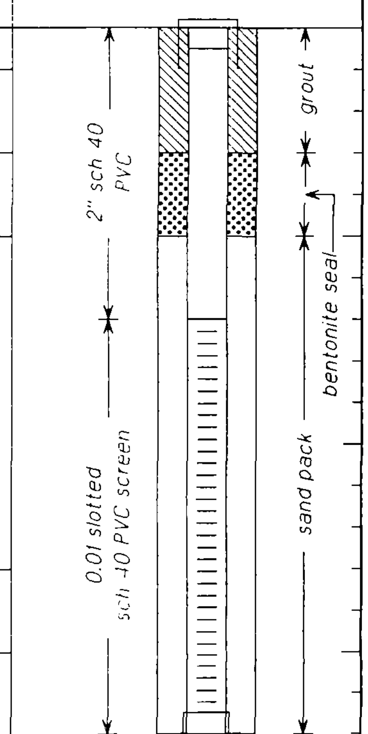
At 21 feet, 3" spoon.

At 22.5 feet, olive-green clay and silt nodules present, gravel up to 0.2' in diameter.

Water saturated loose to slightly firm, medium-grained SAND with 10% well-rounded gravel and shell fragments, many with product coatings.

End of Boring at 25 Feet. PID Background 2.4 PPM.

WELL DIAGRAM



MONITORING WELL GM-20D

Soil Investigation
Rock Island, Illinois

Project No.: CI0299.006
Logged by: Ray Flynn
Drilling Co.: Rock and Soil
Driller: Dusty Jackson

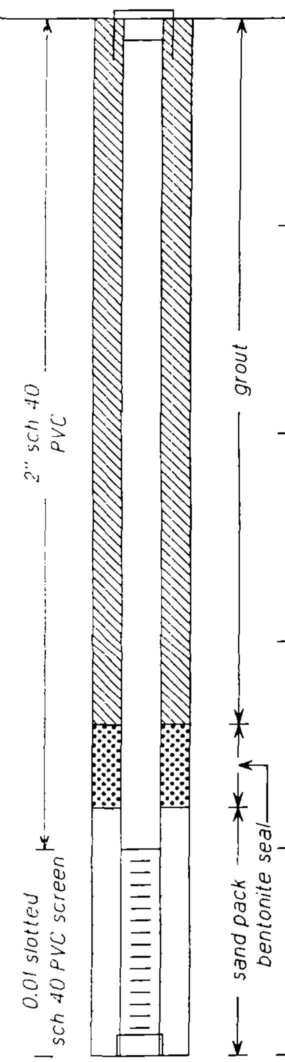
Date Drilled: June 21, 1995
Drilling Method: 8-inch dia. hollow stem
Sampling Method: 2-inch dia. split spoon
Surface Elev.: 568.11
Measuring Pt. Elev.: 567.86

Blows/ft.	OVM (ppm)
22	12.6
26	7.6
23	15.3
37	62.0
12	66.9
25	31.5
40	87.7
5	96.0
8	95.3
25	125.0
17	136.0
10	75.9

Depth (feet): 5, 10, 15, 20, 25, 30

Soil Class	GENERALIZED DESCRIPTION
	CONCRETE.
SP	Dry, loose, uniform, dark-brown, medium SAND with 5% orange patches.
	Slightly firm SAND with loose, coarse, pale-brown glass, dry.
	Black, medium, uniform SAND, slightly firm to dry, occasional dark brown patches. At 7-9 feet, angular to subangular gravel fragments up to 1 cm in diameter, loose. At 10 feet, 0.3' gray-brown, slightly firm, silty SAND layer.
GP	At 13 feet, 0.3' saturated, loose concrete and slag GRAVEL.
	3" spoon. Slag GRAVEL with coarse angular black sand, loose, saturated, containing 5% well-rounded quartz pebbles. Slag fragments up to 0.2' in diameter.
CL	Saturated GRAVEL with abundant rounded pebbles (variable composition) on 10" of loose, saturated, black, medium SAND, strong odor.
SP	Damp, olive-green CLAY with diesel coating.
	Coarse, medium, green SAND and 40% gravel matrix, product-saturated, well-rounded gravel fragments of variable composition, loose. At 21 feet, 3" spoon. At 22.5 feet, olive-green clay and silt nodules present, gravel up to 0.2' in diameter.
	Water saturated loose to slightly firm, medium-grained SAND with 10% well-rounded gravel and shell fragments, many with product coatings.
	End of Boring at 25 Feet. PID Background 2.4 PPM.

WELL DIAGRAM



MONITORING WELL GM-20AB

Soil Investigation
Rock Island, Illinois

Project No.: CI0299.006
Logged by: Ray Flynn
Drilling Co.: Rock and Soil
Driller: Eric

Date Drilled: June 8, 1995
Drilling Method: 8-inch dia. hollow stem
Sampling Method: 2-inch dia. split spoon
Surface Elev.:
Measuring Pt. Elev.:

Depth (feet)	Blows/ft.	OVM (ppm)	Samples	Graphic Log	Soil Class
	32	30.3			SP
5	20	23.1			
	26	31.5			
	24	26.1			
10	8	22.5			
	6	25.5			
15	61	21.7			
	16	16.3			
20					
	18	366.9			ML
25					
30					

GENERALIZED DESCRIPTION

1' of CONCRETE, over 4" pale-gray, loose, dry concrete fragments.

0.8' medium to coarse, loose, dry black SAND with occasional orange mottling, over 0.2' of red-orange SAND with same composition and texture as above, final 0.2' black SAND with same composition and texture.

At 3-5 feet, contains <5% large, angular pebbles broken by auger.

At 5-7 feet, wet with strong odor in lowest 2", red-orange and pale gray mottling.

Top 10" medium to coarse, black SAND containing 0.3' coarse grained SAND horizon. Lowest 1', buff brown, medium to fine SAND with 30% black stains, loose and damp.

Pale yellow-brown, medium SAND with texture as in overlying sample, damp and loose. Final 4", black, medium SAND with 10% pale yellow- brown mottling, composition and texture, as above.

Saturated, loose, black, medium grained SAND. At 11.5' and 12', 1" horizons of very coarse, angular glass SAND. 10% pebbles of slag. Slight odor.

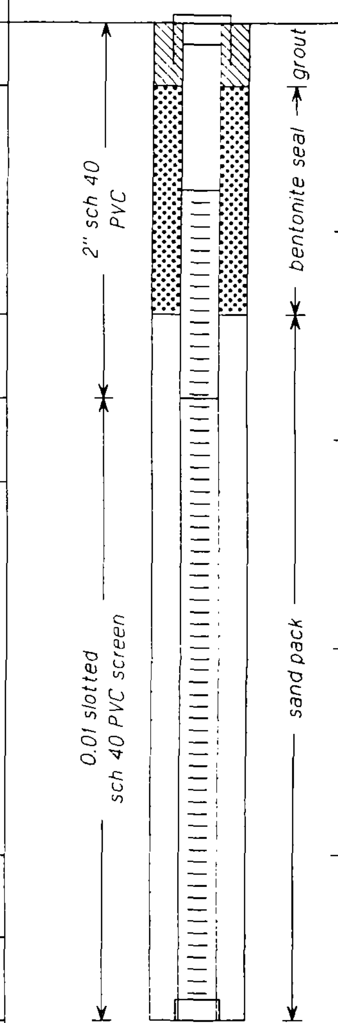
At 13-15 feet, 5% pale gray and orange-brown patches.

At 15-17 feet, slightly stiffer.

Top 15", stiff, moist, olive-green, clayey SILT. 0.3' thick, coarse, loose, angular to subrounded pebble GRAVEL. Saturated with product.

End of Boring at 24 Feet. PID Background 10 PPM.
ABANDONED ON 6-22-95.

WELL DIAGRAM



MONITORING WELL GM-21

Soil Investigation
Rock Island, Illinois

Project No.: CI0299.006
Logged by: Ray Flynn
Drilling Co.: Rock and Soil
Driller: Eric

Date Drilled: June 8, 1995
Drilling Method: 8-inch dia. hollow stem
Sampling Method: 2-inch dia. split spoon
Surface Elev.: 568.0
Measuring Pt. Elev.: 571.37

Depth (feet)	Blows/ft.	OVM (ppm)	Samples	Graphic Log	Soil Class
	36	21.5			FILL
	97	12.5			SP
5					
	13	15.6			
	5	13.9			
10	8	12.2			
	6	12.9			
	11	12.5			
15					
	7	12.5			
	25	11.7			
20					
					GP
	12	12.0			
25					

GENERALIZED DESCRIPTION

0.5' of pale gray, sandy, gravel FILL on dark orange-brown, sandy FILL, loose & dry.

Dry, loose, dark-brown to black, uniform, fine to medium SAND (90%) with occasional orange-brown patches.

Dark brown, loose to slightly firm silty SAND with 20% slag and cinder gravel. Dry to slightly damp.

At 5'-5.4' pale green-gray, dry, slightly firm uniform medium to fine SAND on black, medium to coarse, dry, slightly cohesive SAND.

Black, fine-grained, dry and loose to slightly firm SAND with occasional subangular to subrounded pebbles up to 0.1' in diameter, variable composition (sandstone and limestone).

Dark gray to black, very damp, uniform medium SAND, occasional pale brown and orange patches, less than 5% pebbles.

At 13.5 feet, 2" layer of pale, red-orange, medium to coarse SAND.

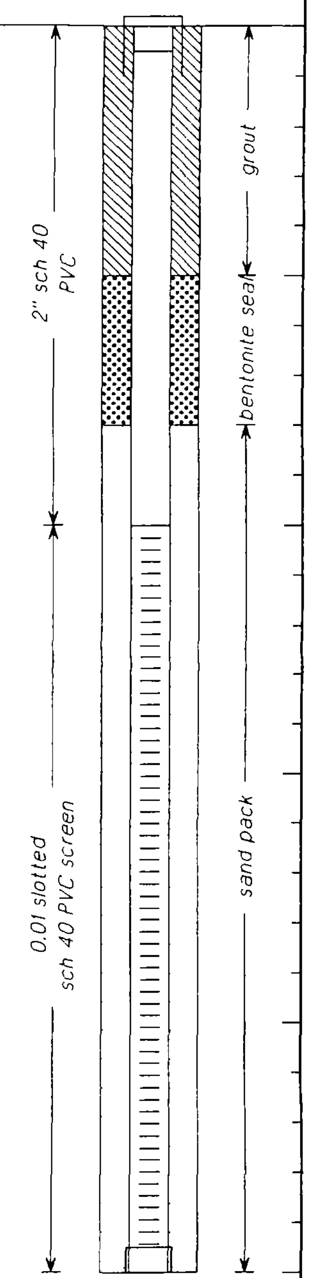
At 14 feet, subrounded to well-rounded pebbles up to 2.5 cm in diameter.

0.5' dark olive-green, coarse, wet, cohesive SAND, approx. 10% silt, on dark, blue-black uniform, medium SAND with 10% white mottling.

Medium to coarse, very dark olive-green to black SAND with approx. 10% silt, occasional 0.05' in diameter, well-rounded siltstone and sandstone pebbles, wet and slightly firm.

23-23.1' as above, 23.1-23.7' very dark olive-green, very silty, shell-rich GRAVEL, 40% silt, firm and saturated, well-rounded pebblesup to 0.1' in diameter. 23.7-25' subangular to angular, clean, loose, variable composition GRAVEL.

WELL DIAGRAM



MONITORING WELL GM-21

Soil Investigation
Rock Island, Illinois

Depth (feet)	Blows/ft.	OVM (ppm)	Samples	Graphic Log	Soil Class	GENERALIZED DESCRIPTION	WELL DIAGRAM
30							
35	137		I			No Recovery.	
40	94	9.0	I		GP	Silty sand and well-rounded, variable composition GRAVEL. Lowest 0.05 foot is fresh shale.	
45	202	8.9	I		GP	Soft, fresh, black, fissile SHALE.	
						End of Boring at 46 Feet. PID Background 9.8 PPM	
50							
55							
60							
65							
70							
75							

MONITORING WELL GM-22S

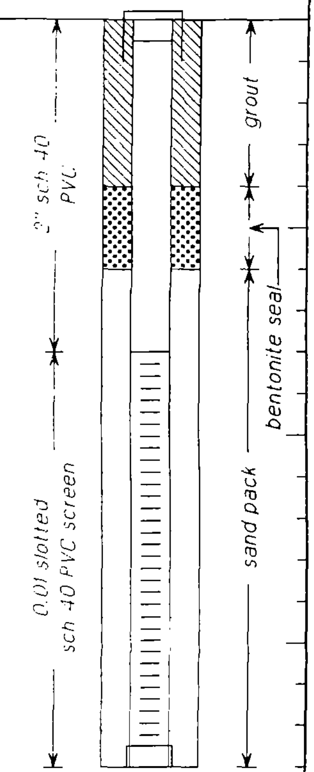
Soil Investigation
Rock Island, Illinois

Project No.: C:0299.006
Logged by: Ray Flynn
Drilling Co.: Rock and Soil
Driller: Eric

Date Drilled: June 9, 1995
Drilling Method: 8-inch dia. hollow stem
Sampling Method: 2-inch dia. split spoon
Surface Elev.: 568.1
Measuring Pt. Elev.: 570.77

Depth (feet)	Blows/ft.	OVM (ppm)	Soil Class	GENERALIZED DESCRIPTION
	26	12.3	SM	Dark-brown, loose, dry, fine to medium grained silty SAND (60%), 10% pebbles.
	19	16.3		Dark-brown to black, uniform medium SAND with 30% orange to pale yellow-gray patches. Lowest 1", broken, angular pebble fragments.
5	32	17.2	GP	
	21	15.1	SM	Black, angular, silty slag GRAVEL, loose to slightly firm, dry to slightly damp. At 6.5', loose, medium-brown to black uniform SAND, as above.
	45	18.0	GP	Black to dark-gray uniform medium SAND with occasional rusty-orange staining, damp, slightly firm.
10				Silty, sandy, angular, black shale GRAVEL with lesser amounts of slag fragments (20%), damp and slightly firm.
	45	17.9	SM	Damp, firm to very firm, uniform medium SAND, 10% angular gravel fragments of shale/slag.
	18	13.3		Saturated firm black SAND, 10% subangular to subrounded pebbles up to 3 cm. 2 silty gravel horizons at 13' and 13.5'.
15	12	16.3		2" black angular gravel, as above, over medium grained firm saturated black SAND, contains 1" nodules of very firm cohesive dark olive-green silt at 16' and 16.6'.
	43	15.8		At 17.5 feet, 5" of timber fragments.
	13	113.5		At 19 feet, CLAY (according to driller.)
20	71	64.5		
	86		GP	Angular to rounded pebbly GRAVEL of variable composition. Free product in sample.
25				
				End of Boring at 27 Feet. PID Background 13.6 PPM.
30				

WELL DIAGRAM



MONITORING WELL GM-22D

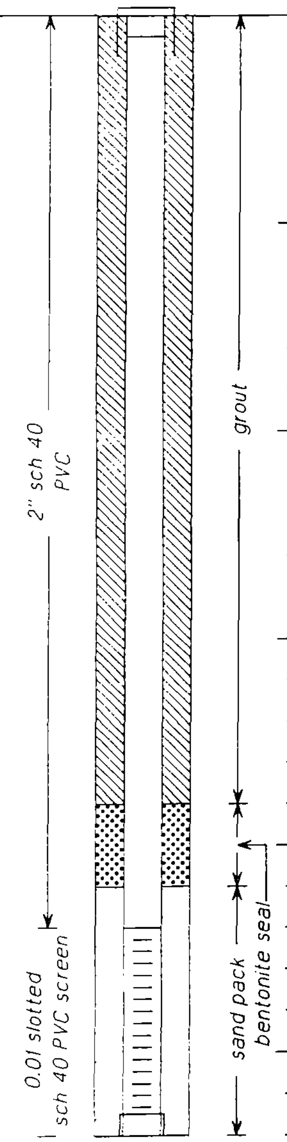
Soil Investigation
Rock Island, Illinois

Project No.: CI0299.006
Logged by: Ray Flynn
Drilling Co.: Rock and Soil
Driller: Eric

Date Drilled: June 9, 1995
Drilling Method: 8-inch dia. hollow stem
Sampling Method: 2-inch dia. split spoon
Surface Elev.: 568.2
Measuring Pt. Elev.: 571.09

Depth (feet)	Blows/ft.	OVM (ppm)	Samples	Graphic Log	Soil Class	GENERALIZED DESCRIPTION
	26	12.3			SM	Dark-brown, loose, dry, fine to medium grained silty SAND (60%), 10% pebbles.
	19	16.3				Dark-brown to black, uniform medium SAND with 30% orange to pale yellow-gray patches. Lowest 1" broken, angular pebble fragments.
5	32	17.2			GP	
					SM	Black, angular, silty slag GRAVEL, loose to slightly firm, dry to slightly damp. At 6.5', loose, medium-brown to black uniform SAND, as above.
	21	15.1				
					GP	Black to dark-gray uniform medium SAND with occasional rusty-orange staining, damp, slightly firm.
	45	18.0				
10						Silty, sandy, angular, black shale GRAVEL with lesser amounts of slag fragments (20%), damp and slightly firm.
	45	17.9			SM	
						Damp, firm to very firm, uniform medium SAND, 10% angular gravel fragments of shale/slag.
	18	13.3				
						Saturated firm black SAND, 10% subangular to subrounded pebbles up to 3 cm. 2 silty gravel horizons at 13' and 13.5'.
15	12	16.3				
						2" black angular gravel, as above, over medium grained firm saturated black SAND, contains 1" nodules of very firm cohesive dark olive-green silt at 16' and 16.6'.
	43	15.8				
	13	113.5				At 17.5 feet, 5" of timber fragments.
20						At 19 feet, CLAY (according to driller.)
	71	64.5				
					GP	Angular to rounded pebbly GRAVEL of variable composition. Free product in sample.
	86					
25						
						End of Boring at 27 Feet. PID Background 13.6 PPM.
30						

WELL DIAGRAM



MONITORING WELL GM-23S

Soil Investigation
Rock Island, Illinois

Project No.: CI0299.006	Date Drilled: June 21, 1995
Logged by: Ray Flynn	Drilling Method: 8-inch dia. hollow stem
Drilling Co.: Rock and Soil	Sampling Method: 2-inch dia. split spoon
Driller: Dusty Jackson	Surface Elev.: 568.01
	Measuring Pt. Elev.: 568.01

Depth (feet)	Blows/ft.	OVM (ppm)	Samples	Graphic Log	Soil Class
	56	18.8			SP
	21	8.4			
5	10	11.2			
	71	38.8			
10	58	12.4			
	24	18.5			
15	60	11.2			
	9	5.1			
	4	20.3			
20	5	2.0			CL
	8	9.7			
	23	162.6			GP
25	35	115.5			
30		74.7			GP
	9	97.5			GP
35					

GENERALIZED DESCRIPTION

CONCRETE, cored.

Dark-brown to black, dry, loose to slightly firm, uniform medium SAND. 5% pebbles up to 1 cm in diameter, slag and timber fragments.

As above with coarse glass SAND horizon at 4-5" over 0.3' long single slag fragment. Dry.

Top 0.8' coarse angular glass SAND with 20% red-orange medium SAND overlying damp, black, uniform medium SAND, loose.

SAND as above with 5-10% subrounded to well-rounded pebbles up to 1 cm in diameter.

Firm, saturated, medium uniform black SAND with slag fragments up to 2 cm in diameter.

0.8' medium, uniform saturated black SAND over 0.1' coarse glass SAND over medium uniform black SAND as at top of sample.

Top 0.9' saturated SAND as above, over 0.2' coarse slag GRAVEL, over 0.2' medium SAND as at top of sample.

Very firm to stiff, damp, olive-green CLAY. Lowest 0.1' of sample contains 2x5mm thick stringers of medium sand.

Product-saturated sandy GRAVEL. Well-rounded pebbles broken by split spoon. Matrix of 40% dark-gray coarse sand. Loose.

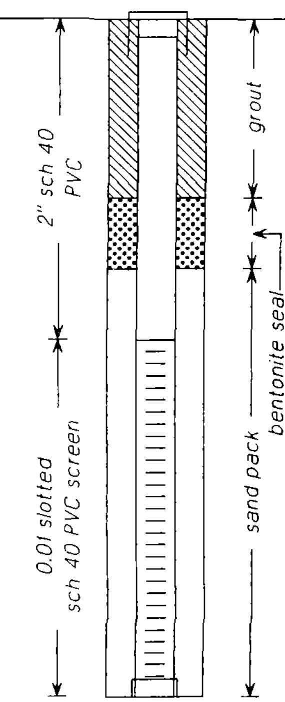
At 25 feet, 3" diameter split spoon. Shells and gravel, >4 cm in diameter.

Very coarse sand, loose, product saturated variable composition GRAVEL, well rounded pebbles up to 3 cm in diameter.

As above.

End of Boring at 32 Feet. PID Background 3.4 PPM.

WELL DIAGRAM



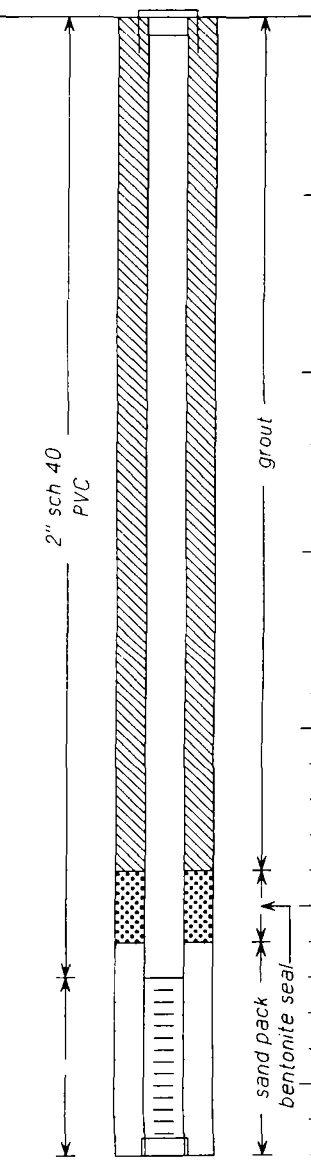
MONITORING WELL GM-23D

Soil Investigation
Rock Island, Illinois

Project No.: CI0299.006	Date Drilled: June 21, 1995
Logged by: Ray Flynn	Drilling Method: 8-inch dia. hollow stem
Drilling Co.: Rock and Soil	Sampling Method: 2-inch dia. split spoon
Driller: Dusty Jackson	Surface Elev.: 568.02
	Measuring Pt. Elev.: 568.02

Depth (feet)	Blows/ft.	OVM (ppm)	Samples	Graphic Log	Soil Class	GENERALIZED DESCRIPTION
						CONCRETE, cored.
	56	18.8			SP	Dark-brown to black, dry, loose to slightly firm, uniform medium SAND, 5% pebbles up to 1 cm in diameter, slag and timber fragments.
	21	8.4				
5	10	11.2				As above with coarse glass SAND horizon at 4-5" over 0.3' long single slag fragment. Dry.
	71	38.8				Top 0.8' coarse angular glass SAND with 20% red-orange medium SAND overlying damp, black, uniform medium SAND, loose.
10	58	12.4				SAND as above with 5-10% subrounded to well-rounded pebbles up to 1 cm in diameter.
	24	18.5				
	60	11.2				Firm, saturated, medium uniform black SAND with slag fragments up to 2 cm in diameter.
15	9	5.1				
	4	20.3				0.8' medium, uniform saturated black SAND over 0.1' coarse glass SAND over medium uniform black SAND as at top of sample.
20	5	2.0			CL	Top 0.9' saturated SAND as above, over 0.2' coarse slag GRAVEL, over 0.2' medium SAND as at top of sample.
	8	9.7				
	23	162.6			GP	Very firm to stiff, damp, olive-green CLAY. Lowest 0.1' of sample contains 2x5mm thick stringers of medium sand.
25	35	115.5				Product-saturated sandy GRAVEL. Well-rounded pebbles broken by split spoon. Matrix of 40% dark-gray coarse sand. Loose. At 25 feet, 3" diameter split spoon. Shells and gravel, >4 cm in diameter.
30		74.7			GP	Very coarse sand, loose, product saturated variable composition GRAVEL, well rounded pebbles up to 3 cm in diameter.
	9	97.5			GP	As above.
35						End of Boring at 32 Feet. PID Background 3.4 PPM.

WELL DIAGRAM



MONITORING WELL GM-23AB

Soil Investigation
Rock Island, Illinois

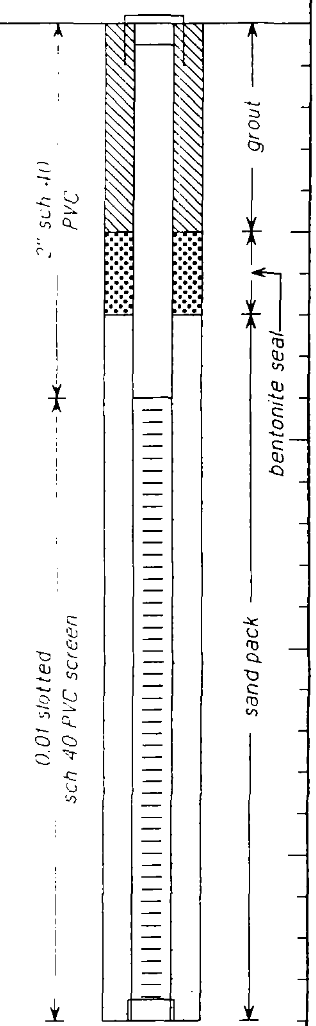
Project No.: C10299.006
Logged by. Ray Flynn
Drilling Co.: Rock and Soil
Driller: Eric

Date Drilled: June 9, 1995
Drilling Method: 8-inch dia. hollow stem
Sampling Method: 2-inch dia. split spoon
Surface Elev.: 569.93
Measuring Pt. Elev.:

Depth (feet)	Blows/ft.	OVM (ppm)	Soil Class	GENERALIZED DESCRIPTION
0–2				CONCRETE, cored.
2–8	76	31.9	SP	0.2' of broken concrete over 0.3' dark-brown, silty, gravelly, medium to fine SAND, dry and loose. Overlying dry, firm, black, uniform, medium SAND containing 10% brown and gray patches.
5	5	26.9		
	4	23.6		
8–10	7	236.5		Very coarse glass SAND and occasional 2 cm pebbles of slag.
10–12	7	337.1		Uniform damp, loose, medium SAND in discrete layers of different color ranging from black to pale yellow-brown.
12–17	18	265.3		Loose, damp, medium grained black SAND, uniform and diesel saturated, contains wood and slag fragments.
15	17	266.2		
	6	253.6		
17–19	20	271.5	CL	Olive-green, stiff, silty CLAY containing rootlets, sample taken for grain size analysis.
19–22	22	93.5	GP	Coarse, subrounded, sandy GRAVEL up to 3 cm in diameter (broken fragements).
22–24	26	375.5	SP	Coarse green-gray SAND with shells, moderately firm, over 0.2' of sandy GRAVEL with rounded pebbles (70%), over 0.2' firm, dark, olive- green silt over 0.5' of blue-gray gravelly SAND containing 30% well- rounded gravel fragments.

End of Boring at 24 Feet. Background PID 10.4 PPM.
ABANDONED ON 6-23-95.

WELL DIAGRAM



MONITORING WELL GM-24S

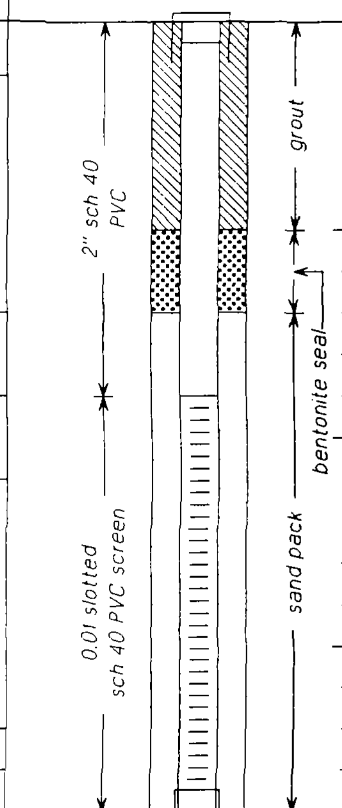
Soil Investigation
Rock Island, Illinois

Project No.: CI0299.006
Logged by: Ray Flynn
Drilling Co.: Rock and Soi
Driller: Dusty Jacksc

Date Drilled: June 22, 1995
Drilling Method: 8-inch dia. hollow stem
Sampling Method: 2-inch dia. split spoon
Surface Elev.: 567.19
Measuring Pt. Elev.: 567.81

Depth (feet)	Blows/ft.	OVM (ppm)	Soil Class	GENERALIZED DESCRIPTION
				CONCRETE, cored.
	18	31.8	SP	Medium to fine grained, dry, loose, black SAND, 5% slag fragments up to 1" in diameter.
	14	32.0		
5	26	25.7		
	24	23.3		SAND as above, although slightly firm. Nodule of stiff, damp, olive- green clay at 8.5'.
10	13	28.7		SAND as above, clay in lowest 0.4' with 10% broken pebbles.
	8	160.3		Damp, dark-brown, diesel-contaminated, medium-grained, uniform SAND. 0.3' of clay in SAND layers, contains timber fragments.
	15	171.2		
15	7	170.4		
	4	168.9		Product-saturated SAND.
			CL	Stiff, olive-green, damp CLAY containing wood fragments.
20	28	126.8	GP	Coarse, subangular to angular, loose, product-saturated GRAVEL. Dark yellow-green sand matrix.
	47	177.2		3" diameter spoon. Coarse, well-rounded, product-saturated, loose, variable composition GRAVEL, 40% pebbles 0.1' in diameter, 40% coarse yellow-green sand matrix.
25	10	86.9		
	15	188.6	SP	0.5' fine to medium-grained green SAND over coarse GRAVEL. Product saturated.
				Very firm, medium to fine green SAND, product-saturated.
30				End of Boring at 26 Feet.

WELL DIAGRAM



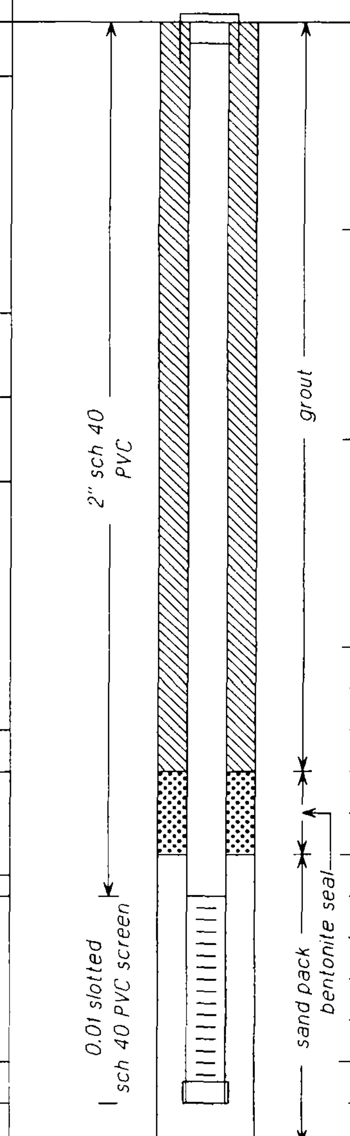
MONITORING WELL GM-24D

Soil Investigation
Rock Island, Illinois

Project No.: C10299.006	Date Drilled: June 22, 1995
Logged by: Ray Flynn	Drilling Method: 8-inch dia. hollow stem
Drilling Co.: Rock and Soil	Sampling Method: 2-inch dia. split spoon
Driller: Dusty Jackson	Surface Elev.: 568.21
	Measuring Pt. Elev.: 567.94

Depth (feet)	Blows/ft.	OVM (ppm)	Samples	Graphic Log	Soil Class	GENERALIZED DESCRIPTION
						CONCRETE, cored.
5	7				SP	Medium to fine grained, dry, loose, black SAND, 5% slag fragments up to 1" in diameter.
						SAND as above, although slightly firm. Nodule of stiff, damp, olive- green clay at 8.5'.
10	17					SAND as above, clay in lowest 0.4' with 10% broken pebbles.
15	104					Damp, dark-brown, diesel-contaminated, medium-grained, uniform SAND. 0.3' of clay in SAND layers, contains timber fragments.
	75					Product-saturated SAND.
20	10				CL	Stiff, olive-green, damp CLAY containing wood fragments.
					GP	Coarse, subangular to angular, loose, product-saturated GRAVEL. Dark yellow-green sand matrix.
25	28					3" diameter spoon. Coarse, well-rounded, product-saturated, loose, variable composition GRAVEL, 40% pebbles 0.1' in diameter, 40% coarse yellow-green sand matrix.
	4				SP	0.5' fine to medium-grained green SAND over coarse GRAVEL. Product saturated.
						Very firm, medium to fine green SAND, product-saturated.
30						End of Boring at 26 Feet.

WELL DIAGRAM



MONITORING WELL GM-25S

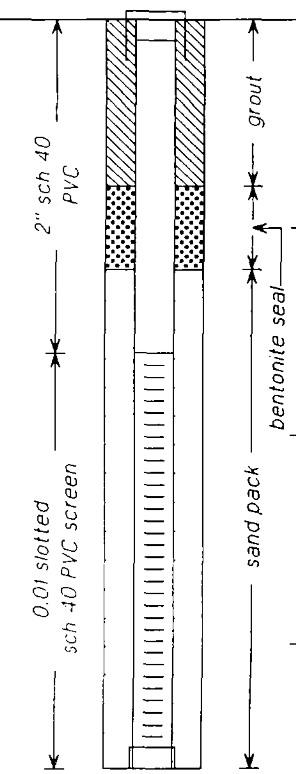
Soil Investigation
Rock Island, Illinois

Project No.: C10299.006
Logged by: Ray Flynn
Drilling Co.: Rock and Soil
Driller: Dusty Jackson

Date Drilled: June 22, 1995
Drilling Method: 8-inch dia. hollow stem
Sampling Method: 2-inch dia. split spoon
Surface Elev.: 568.75
Measuring Pt. Elev.: 568.47

Depth (feet)	Blows/ft.	OVM (ppm)	Soil Class	GENERALIZED DESCRIPTION
				CONCRETE, cored.
	12	11.4	SP	Uniform, dry, loose, black, medium SAND, 5% slag pebbles.
5	6	3.3		At 6 feet, slag rich, rubbley layer, dry and loose.
	33	3.5		At 7-9 feet, damp and slightly firm.
	16	0.5		At 9-11 feet, 15% rounded pebbles of slag.
10	32	3.9		
	28	6.5		At 11-13 feet, damp, dark olive-green, firm, silty SAND, 20% rounded pebbles. Metal and glass fragments noted.
	10	4.0		Medium SAND. Top 1' very damp, lower 1' saturated. 0.1' silty horizon containing 10% slag at 14.9'.
15	8	1.7		Loose, saturated, black, medium SAND with coarse, angular slag at 16.3', 15% rounded quartz pebbles up to 1 cm in diameter.
	4	11.8		
			CL	1.5' of stiff, olive-green, damp CLAY. (Clay sampled for grain size analysis.)
20	12	125.6	SP	
	20	149.9		Pale green, coarse SAND with 10-15% rounded GRAVEL of variable composition, product-saturated and loose.
	16	150.2		Abundant GRAVEL and shells from 22.3'-22.6', SAND with 10% gravel, product-saturated and loose.
25	29	51.8	GP	3" diameter spoon. 24.4'-25', coarse, pebble rich (30%) sand over 0.2' of sandy GRAVEL, well-rounded pebbles up to 4.5 cm in diameter on soft, dark-brown green gravel-free silt.
				GRAVEL as above with abundant broken rock fragments.
30				End of Boring at 26.5 Feet.

WELL DIAGRAM



MONITORING WELL GM-25D

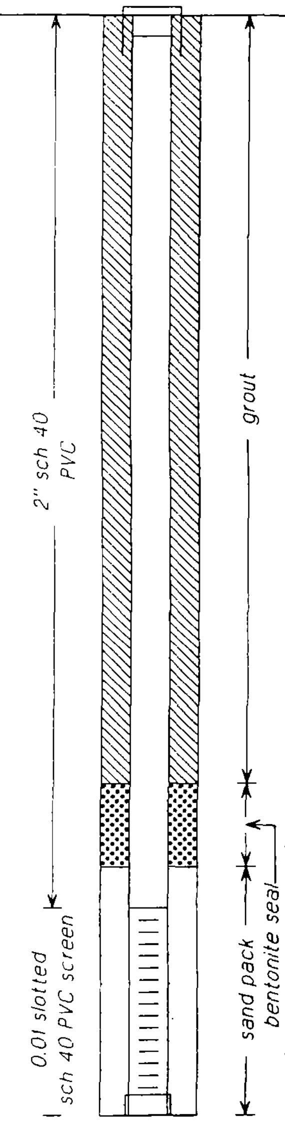
Soil Investigation
Rock Island, Illinois

Project No.: CI3299.006	Date Drilled: June 22, 1995
Logged by: Ray Flynn	Drilling Method: 8-inch dia. hollow stem
Drilling Co.: Rock and Soil	Sampling Method: 2-inch dia. split spoon
Driller: Dusty Jackson	Surface Elev.: 568.80
	Measuring Pt. Elev.: 568.59

Blows/ft.	OVM (ppm)
12	1.4
6	3.3
33	3.5
16	0.5
32	3.9
28	6.5
10	4.0
8	1.7
4	11.8
12	125.6
20	149.9
16	150.2
29	51.8

Soil Class	GENERALIZED DESCRIPTION
	CONCRETE, cored.
SP	Uniform, dry, loose, black, medium SAND, 5% slag pebbles.
	At 6 feet, slag rich, rubbley layer, dry and loose.
	At 7-9 feet, damp and slightly firm.
	At 9-11 feet, 15% rounded pebbles of slag.
	At 11-13 feet, damp, dark olive-green, firm, silty SAND, 20% rounded pebbles. Metal and glass fragments noted.
	Medium SAND. Top 1' very damp, lower 1' saturated. 0.1' silty horizon containing 10% slag at 14.9'.
	Loose, saturated, black, medium SAND with coarse, angular slag at 16.3', 15% rounded quartz pebbles up to 1 cm in diameter.
CL	1.5' of stiff, olive-green, damp CLAY. (Clay sampled for grain size analysis.)
SP	Pale green, coarse SAND with 10-15% rounded GRAVEL of variable composition, product-saturated and loose.
	Abundant GRAVEL and shells from 22.3'-22.6', SAND with 10% gravel, product-saturated and loose.
GP	3" diameter spoon. 24.4'-25', coarse, pebble rich (30%) sand over 0.2' of sandy GRAVEL, well-rounded pebbles up to 4.5 cm in diameter on soft, dark-brown green gravel-free silt.
	GRAVEL as above with abundant broken rock fragments.
	End of Boring at 26.5 Feet.

WELL DIAGRAM



MONITORING WELL GM-26S

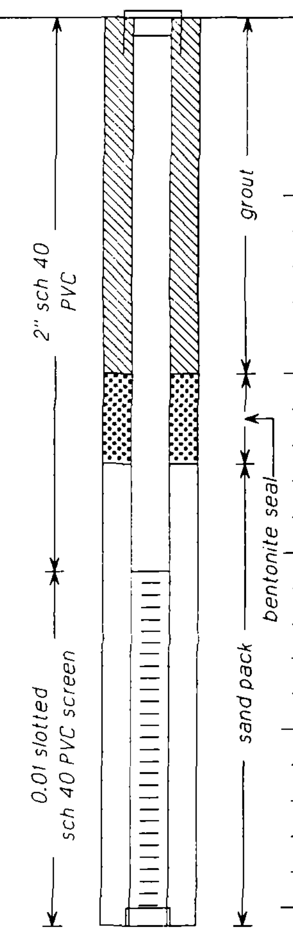
Soil Investigation
Rock Island, Illinois

Project No.: CI0299.006	Date Drilled: July 31, 1995
Logged by: Ray Flynn	Drilling Method: 8-inch dia. hollow stem
Drilling Co.: Rock and Soil	Sampling Method: 2-inch dia. split spoon
Driller: Dusty Jackson	Surface Elev.: 572.69
	Measuring Pt. Elev.: 572.35

Depth (feet)	Blows/ft.	OVM (ppm)	Soil Class	GENERALIZED DESCRIPTION
				CONCRETE, cored.
			SP	Dark brown to black medium SAND, uniform, dry, loose with occasional well-rounded pebbles (5%) of predominantly slag, minor amounts of wood.
	58	5.6		At 3 ft, no pebbles.
5	14	10.1		From 5 to 11 ft, slightly damp.
	17	3.4		
	18	24.1		
10	8	8.7		From 11 to 13 ft, very damp to saturated.
	13	16.3		From 13 to 15 ft, no recovery.
15				From 15 to 19 ft, saturated.
	20	18.0		
	16	8.5		From 19 to 21 ft, SAND with 20% pale green pebbles greater than 5mm in diameter.
20	100	10.5		
	8	3.6		
25	8	3.9		
			CL	Stiff, damp, olive CLAY containing abundant rootlets.
	6	5.4	GP	Well-rounded, loose, saturated GRAVEL. 40% medium dark yellow-green sand matrix. Gravel of variable composition up to 1 cm in diameter.
	15	12.4		
30	119	15.9		From 29 to 31 ft, with 20% medium green-gray sand matrix.
	35	20		Olive green, silty, coarse GRAVEL matrix with approximately 20% silt and 25% fine to medium yellow-green sand matrix.
35				

End of Boring at 33 Feet.

WELL DIAGRAM



MONITORING WELL GM-26D

Soil Investigation
Rock Island, Illinois

Project No.: CI0299.006
Logged by: Ray Flynn
Drilling Co.: Rock and Soil
Driller: Dusty Jackson

Date Drilled: July 31, 1995
Drilling Method: 8-inch dia. hollow stem
Sampling Method: 2-inch dia. split spoon
Surface Elev.:
Measuring Pt. Elev.:

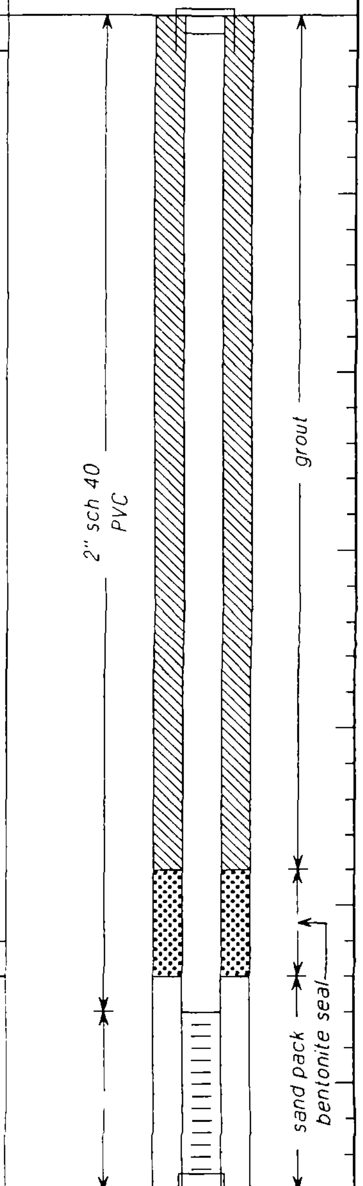
Blows/ft.	OVM (ppm)
58	5.6
14	10.1
17	3.4
18	24.1
8	8.7
13	16.3
20	18.0
16	8.5
100	10.5
8	3.6
8	3.9
6	5.4
15	12.4
119	15.9
35	20

Depth (feet): 5, 10, 15, 20, 25, 30, 35

Soil Class	GENERALIZED DESCRIPTION
	CONCRETE, cored.
SP	Dark brown to black medium SAND, uniform, dry, loose with occasional well-rounded pebbles (5%) of predominantly slag, minor amounts of wood. At 3 ft, no pebbles. From 5 to 11 ft, slightly damp. From 11 to 13 ft, very damp to saturated. From 13 to 15 ft, no recovery. From 15 to 19 ft, saturated. From 19 to 21 ft, SAND with 20% pale green pebbles greater than 5mm in diameter.
CL	Stiff, damp, olive CLAY containing abundant rootlets.
GP	Well-rounded, loose, saturated GRAVEL. 40% medium dark yellow-green sand matrix. Gravel of variable composition up to 1 cm in diameter. *From 29 to 31 ft, with 20% medium green-gray sand matrix.* Olive green, silty, coarse GRAVEL matrix with approximately 20% silt and 25% fine to medium yellow-green sand matrix.

End of Boring at 33 Feet.

WELL DIAGRAM



MONITORING WELL GM-27S

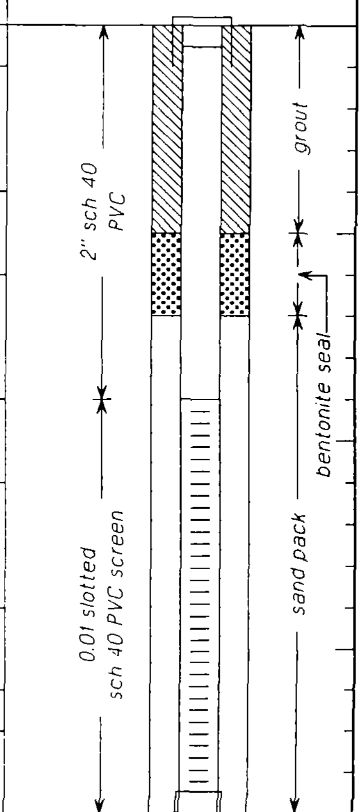
Soil Investigation
Rock Island, Illinois

Project No.: CI0299.006
Logged by: Ray Flynn
Drilling Co.: Rock and Soil
Driller: Dusty Jackson

Date Drilled: August 15, 1995
Drilling Method: 8-inch dia. hollow stem
Sampling Method: 2-inch dia. split spoon
Surface Elev.: 567.70
Measuring Pt. Elev.: 568.00

Depth (feet)	Blows/ft.	OVM (ppm)	Samples	Graphic Log	Soil Class	GENERALIZED DESCRIPTION
0–1						1 foot of CONCRETE.
5	7				SP	Loose to slightly firm, dry, medium grained, uniform SAND with slight hydrocarbon odor.
10	17				SP	SAND as above, although slightly damp with 10% angular slag and limestone fragments.
15	104				SP	SAND as above, although no rock or slag fragments.
	75				SP	Saturated SAND as above, with stiff, abundant (approximately 20%), angular slag fragements.
20	10				CL	Stiff, olive-green, damp CLAY. From 21 to 21.8 feet, diesel coated CLAY.
					GP	Well-rounded, variable composition, loose saturated GRAVEL.
	28				SP	Black, loose, product-saturated, medium SAND with approximately 20% well-rounded, variable composition gravel with fragments up to 2 cm in diameter. From 25 to 25.8 feet, loose, green-gray, coarse to medium SAND.
25	4				GP	Coarse sandy GRAVEL with 40% medium green-gray sand matrix as above. Gravel contains well-rounded fragments of variable composition.
30						End of Boring at 27 Feet.

WELL DIAGRAM



MONITORING WELL GM-27D

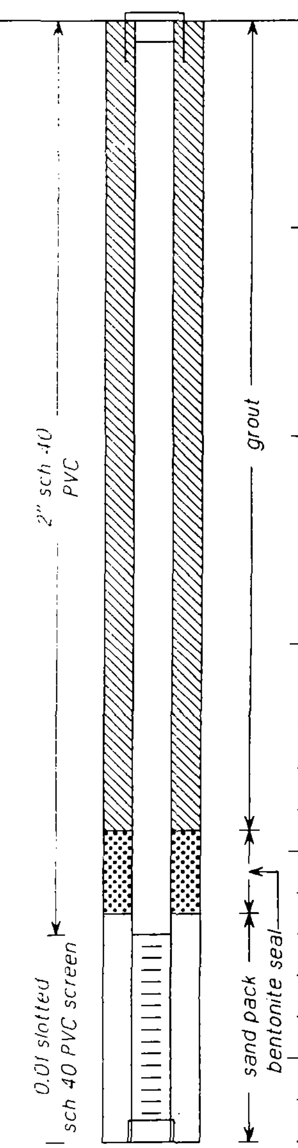
Soil Investigation
Rock Island, Illinois

Project No.: CI0299.006
Logged by: Ray Flynn
Drilling Co.: Rock and Soil
Driller: Dusty Jackson

Date Drilled: August 15, 1995
Drilling Method: 8-inch dia. hollow stem
Sampling Method: 2-inch dia. split spoon
Surface Elev.: 568.03
Measuring Pt. Elev.: 567.65

Depth (feet)	Blows/ft.	OVM (ppm)	Soil Class	GENERALIZED DESCRIPTION
0–1				1 foot of CONCRETE.
5	7		SP	Loose to slightly firm, dry, medium grained, uniform SAND with slight hydrocarbon odor.
10	17		SP	SAND as above, although slightly damp with 10% angular slag and limestone fragments.
15	104		SP	SAND as above, although no rock or slag fragments.
	75		SP	Saturated SAND as above, with stiff, abundant (approximately 20%), angular slag fragements.
20	10		CL	Stiff, olive-green, damp CLAY. From 21 to 21.8 feet, diesel coated CLAY.
			GP	Well-rounded, variable composition, loose saturated GRAVEL.
	28		SP	Black, loose, product-saturated, medium SAND with approximately 20% well-rounded, variable composition gravel with fragments up to 2 cm in diameter. From 25 to 25.8 feet, loose, green-gray, coarse to medium SAND.
25	4		GP	Coarse sandy GRAVEL with 40% medium green-gray sand matrix as above. Gravel contains well-rounded fragments of variable composition.
30				End of Boring at 27 Feet.

WELL DIAGRAM



MONITORING WELL GM-28S

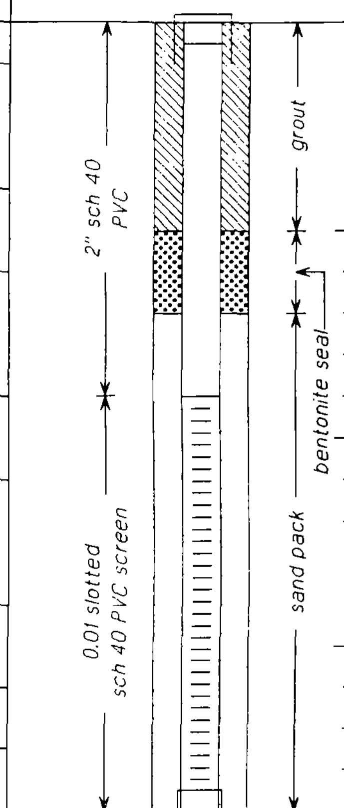
Soil Investigation
Rock Island, Illinois

Project No.: CI0299.006
Logged by: Ray Flynn
Drilling Co.: Rock and Soil
Driller: Dusty Jackson

Date Drilled: August 14, 1995
Drilling Method: 8-inch dia. hollow stem
Sampling Method: 2-inch dia. split spoon
Surface Elev.: 567.88
Measuring Pt. Elev.: 567.55

Depth (feet)	Blows/ft.	OVM (ppm)	Samples	Graphic Log	Soil Class	GENERALIZED DESCRIPTION
0–1			I			1 foot of CONCRETE.
5	7		I		SP	Dark brown to black, medium to fine grained SAND, uniform, loose, and dry.
10	26		I		SP	SAND as above,although slightly damp, containing 5% limestone and slag fragments.
15	8		I		SP	SAND as above, saturated with strong hydrocarbon odor.
					CL	Stiff, damp, olive-green CLAY.
20	17		I		GP	Loose, granular, product-saturated SAND and well-rounded gravel.
25	35		I		SP	Loose, product-saturated, medium to coarse, gray-green SAND with approximately 40% well-rounded variable composition gravel.
	81					
						End of Boring at 28 Feet.
30						

WELL DIAGRAM



MONITORING WELL GM-28D

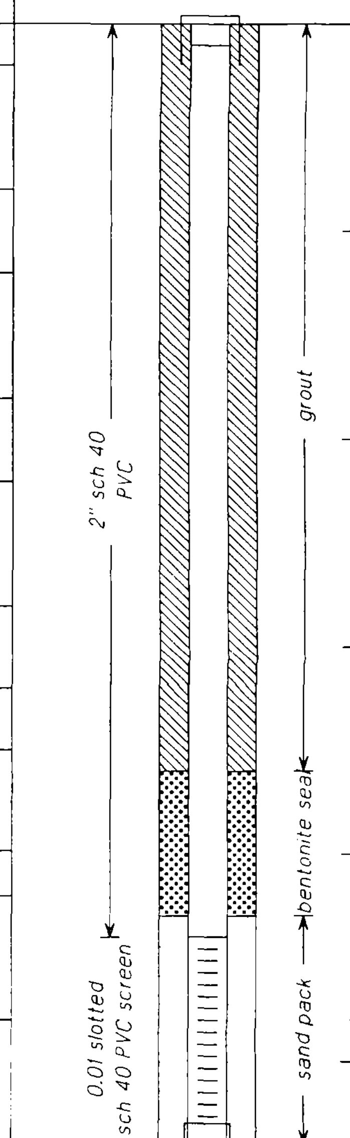
Soil Investigation
Rock Island, Illinois

Project No.: CI0299.006
Logged by: Ray Flynn
Drilling Co.: Rock and Soil
Driller: Dusty Jackson

Date Drilled: August 14, 1995
Drilling Method: 8-inch dia. hollow stem
Sampling Method: 2-inch dia. split spoon
Surface Elev.: 567.89
Measuring Pt. Elev.: 567.60

Depth (feet)	Blows/ft.	OVM (ppm)	Samples	Graphic Log	Soil Class	GENERALIZED DESCRIPTION
			I			1 foot of CONCRETE.
5	7		I		SP	Dark brown to black, medium to fine grained SAND, uniform, loose, and dry.
10	26		I		SP	SAND as above, although slightly damp, containing 5% limestone and slag fragments.
15	8		I		SP	SAND as above, saturated with strong hydrocarbon odor.
					CL	Stiff, damp, olive-green CLAY.
20	17		I		GP	Loose, granular, product-saturated SAND and well-rounded gravel.
25	35		I		SP	Loose, product-saturated, medium to coarse, gray-green SAND with approximately 40% well-rounded variable composition gravel.
	81		I			
						End of Boring at 28 Feet.
30						

WELL DIAGRAM



MONITORING WELL GM-29S

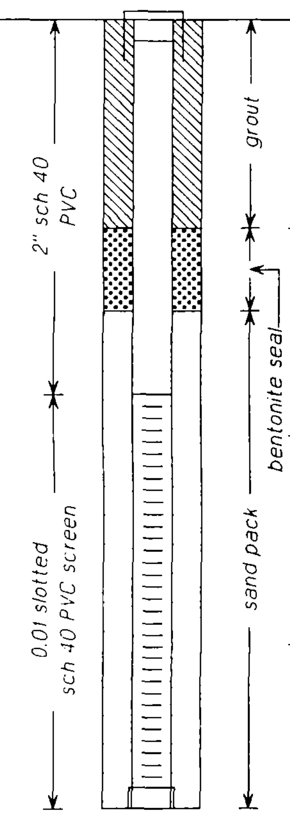
Soil Investigation
Rock Island, Illinois

Project No.: C10299.006
Logged by: Ray Flynn
Drilling Co.: Rock and Soil
Driller: Dusty Jackson

Date Drilled: August 15, 1995
Drilling Method: 8-inch dia. hollow stem
Sampling Method: 2-inch dia. split spoon
Surface Elev.: 568.14
Measuring Pt. Elev.: 567.78

Depth (feet)	Blows/ft.	OVM (ppm)	Samples	Soil Class	GENERALIZED DESCRIPTION
			I		1 foot of CONCRETE.
5	10		I	SP	Loose, dry, medium-grained, uniform, pale brown to black SAND.
10	45		I	SP	Dry to slightly damp SAND as above, loose to slightly firm with approximately 20% slag fragments greater than split spoon diameter (broken by drilling).
15	14		I	SP	Saturated black SAND as above.
	10		I	SP	Saturated black SAND as above.
20	6		I	CL	Stiff, damp, olive-green, silty CLAY containing rootlets.
	10				
	10				
	14				
25			I	SP	Loose, product-saturated, medium to coarse SAND. At 25 to 27 feet with limestone pebbles.
	23				
	58		I	GP	Pebble-rich, loose, product-saturated, silty GRAVEL with 60% well- rounded pebbles in coarse sand matrix with approximately 10% silt.
30					End of Boring at 29 Feet.

WELL DIAGRAM



MONITORING WELL GM-29D

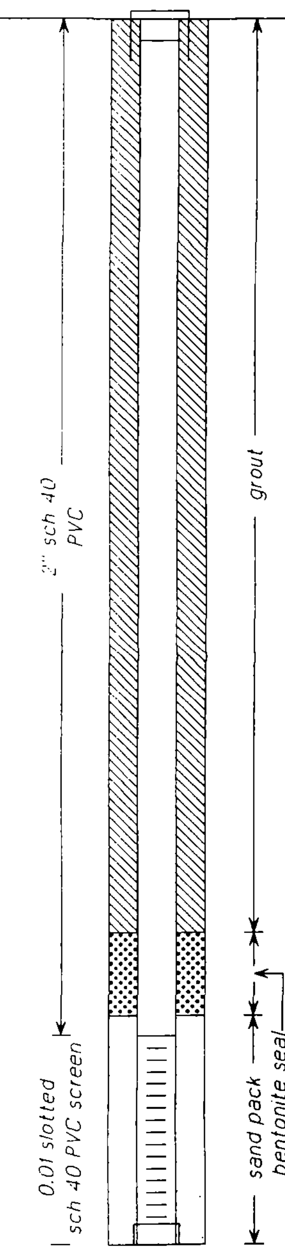
Soil Investigation
Rock Island, Illinois

Project No.: CI0299.006
Logged by: Ray Flynn
Drilling Co.: Rock and Soil
Driller: Dusty Jackson

Date Drilled: August 14, 1995
Drilling Method: 8-inch dia. hollow stem
Sampling Method: 2-inch dia. split spoon
Surface Elev.: 568.13
Measuring Pt. Elev.: 567.83

Depth (feet)	Blows/ft.	OVM (ppm)	Samples	Graphic Log	Soil Class	GENERALIZED DESCRIPTION
0–1						1 foot of CONCRETE.
5	10				SP	Loose, dry, medium-grained, uniform, pale brown to black SAND.
10	45				SP	Dry to slightly damp SAND as above, loose to slightly firm with approximately 20% slag fragments greater than split spoon diameter (broken by drilling).
15	14				SP	Saturated black SAND as above.
	10				SP	Saturated black SAND as above.
20	6				CL	Stiff, damp, olive-green, silty CLAY containing rootlets.
	10					
	10					
	14					
25	23				SP	Loose, product-saturated, medium to coarse SAND. At 25 to 27 feet with limestone pebbles.
	58				GP	Pebble-rich, loose, product-saturated, silty GRAVEL with 60% well- rounded pebbles in coarse sand matrix with approximately 10% silt.
30						End of Boring at 29 Feet.

WELL DIAGRAM



MONITORING WELL OW-30S

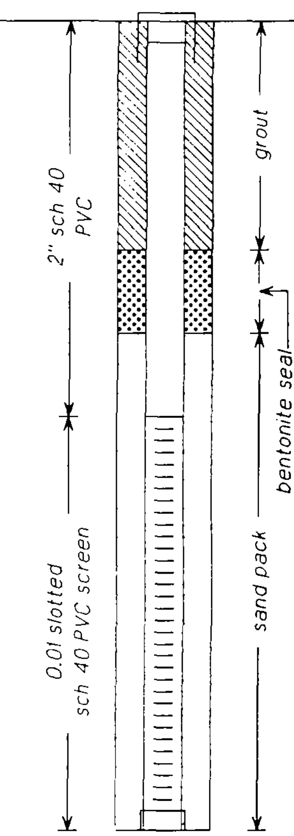
Soil Investigation
Rock Island, Illinois

Project No.: CI0299.006
Logged by: Ray Flynn
Drilling Co.: Rock and So
Driller: Dusty Jacksc

Date Drilled: August 15, 1995
Drilling Method: 8-inch dia. hollow stem
Sampling Method: 2-inch dia. split spoon
Surface Elev.:
Measuring Pt. Elev.:

Depth (feet)	Blows/ft.	OVM (ppm)	Samples	Graphic Log	Soil Class	GENERALIZED DESCRIPTION
0–1						1 foot of CONCRETE.
					SP	
5	10					Loose, dry, medium-grained, uniform, pale brown to black SAND.
10	45					Dry to slightly damp SAND as above, loose to slightly firm with approximately 20% slag fragments greater than split spoon diameter (broken by drilling).
15	14					Saturated black SAND as above.
	10				CL	Saturated black SAND as above.
20	6					
	10				GP	Stiff, damp, olive-green, silty CLAY containing rootlets.
	10					
	14					
25						Loose, product-saturated, medium to coarse SAND. At 25 to 27 feet with limestone pebbles.
	23				SP	
	58					Pebble-rich, loose, product-saturated, silty GRAVEL with 60% well- rounded pebbles in coarse sand matrix with approximately 10% silt.
30						End of Boring at 29 Feet. Well abandoned. Redrilled and completed as GM-29S.

WELL DIAGRAM



MONITORING WELL RW-1

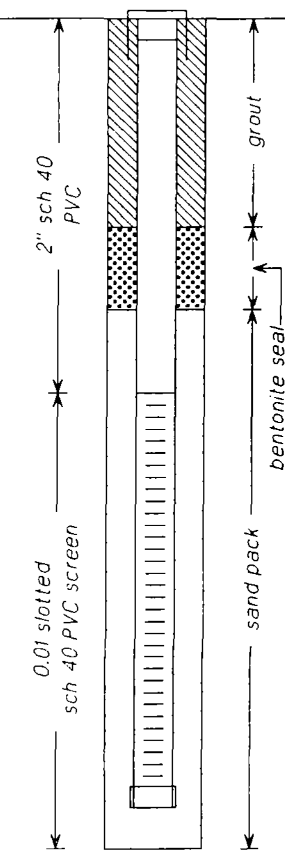
Soil Investigation
Rock Island, Illinois

Project No.: CI0299.006
Logged by: Ray Flynn
Drilling Co.: Rock and Soil
Driller: Dusty Jackson

Date Drilled: August 14, 1995
Drilling Method: 8-inch dia. hollow stem
Sampling Method: 2-inch dia. split spoon
Surface Elev.: 568.05
Measuring Pt. Elev.: 568.86

Depth (feet)	Blows/ft.	OVM (ppm)	Samples	Graphic Log	Soil Class	GENERALIZED DESCRIPTION
						1 foot of CONCRETE.
5	7				SP	Loose to slightly firm, dry, medium grained, uniform SAND with slight hydrocarbon odor.
10	17				SP	SAND as above, although slightly damp with 10% angular slag and limestone fragments.
15	104				SP	SAND as above, although no rock or slag fragments.
	75				SP	Saturated SAND as above, with stiff, abundant (approximately 20%), angular slag fragements.
20	10				CL	Stiff, olive-green, damp CLAY. From 21 to 21.8 feet, diesel coated CLAY.
					GP	Well-rounded, variable composition, loose saturated GRAVEL.
25	28				SP	Black, loose, product-saturated, medium SAND with approximately 20% well-rounded, variable composition gravel with fragments up to 2 cm in diameter. From 25 to 25.8 feet, loose, green-gray, coarse to medium SAND.
	4				GP	Coarse sandy GRAVEL with 40% medium green-gray sand matrix as above. Gravel contains well-rounded fragments of variable composition.
30						End of Boring at 27 Feet.

WELL DIAGRAM



MONITORING WELL RW-2

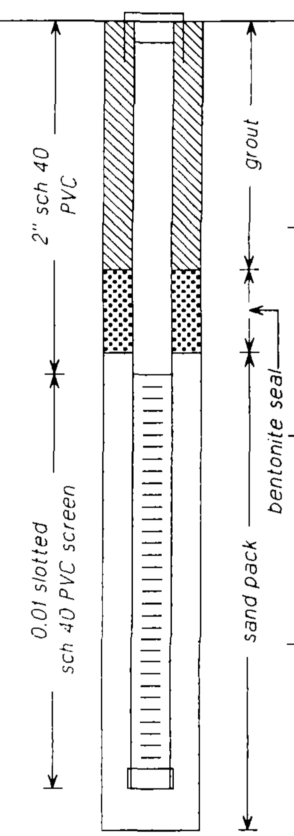
Soil Investigation
Rock Island, Illinois

Project No.: CI0299.006
Logged by: Ray Flynn
Drilling Co.: Rock and Soil
Driller: Dusty Jackson

Date Drilled: August 17, 1995
Drilling Method: 8-inch dia. hollow stem
Sampling Method: 2-inch dia. split spoon
Surface Elev.: 568.14
Measuring Pt. Elev.: 569.71

Depth (feet)	Blows/ft.	OVM (ppm)	Samples	Graphic Log	Soil Class	GENERALIZED DESCRIPTION
0–1			I			1 foot of CONCRETE.
5	7		I		SP	Loose to slightly firm, dry, medium grained, uniform SAND with slight hydrocarbon odor.
10	17		I		SP	SAND as above, although slightly damp with 10% angular slag and limestone fragments.
15	104		I		SP	SAND as above, although no rock or slag fragments.
18	75		I		SP	Saturated SAND as above, with stiff, abundant (approximately 20%), angular slag fragements.
20	10		I		CL	Stiff, olive-green, damp CLAY. From 21 to 21.8 feet, diesel coated CLAY.
22			I		GP	Well-rounded, variable composition, loose saturated GRAVEL.
24	28		I		SP	Black, loose, product-saturated, medium SAND with approximately 20% well-rounded, variable composition gravel with fragments up to 2 cm in diameter. From 25 to 25.8 feet, loose, green-gray, coarse to medium SAND.
26	4		I		GP	Coarse sandy GRAVEL with 40% medium green-gray sand matrix as above. Gravel contains well-rounded fragments of variable composition.
30						End of Boring at 27 Feet.

WELL DIAGRAM



MONITORING WELL RW-3

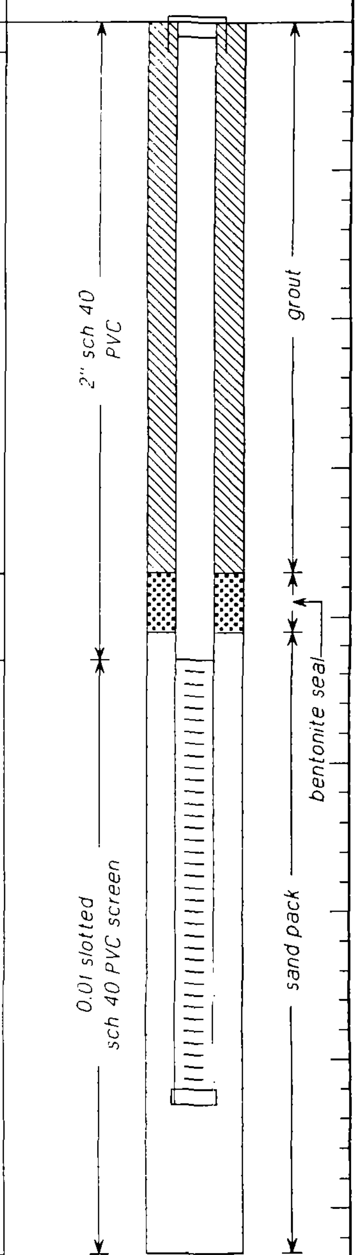
Soil Investigation
Rock Island, Illinois

Project No.: C10299.006
Logged by: Ray Flynn
Drilling Co.: Rock and Soil
Driller: Dusty Jackson

Date Drilled: August 17, 1995
Drilling Method: 8-inch dia. hollow stem
Sampling Method: 2-inch dia. split spoon
Surface Elev.: 568.00
Measuring Pt. Elev.: 568.42

Depth (feet)	Blows/ft.	OVM (ppm)	Samples	Graphic Log	Soil Class	GENERALIZED DESCRIPTION
0–1						1 foot of CONCRETE.
1–18.5					SP	Brown to black, medium to fine-grained, dry to saturated, loose to moderately firm, dry to saturated, uniform foundry SAND.
18.5–21.5	6				CL	Stiff, damp, olive-green, silty CLAY.
21.5–41.5	26				SP	Coarse SAND and well-rounded gravel pebbles of variable composition, pebbles up to greater than spoon diameter.
41.5						End of Boring at 41.5 Feet.

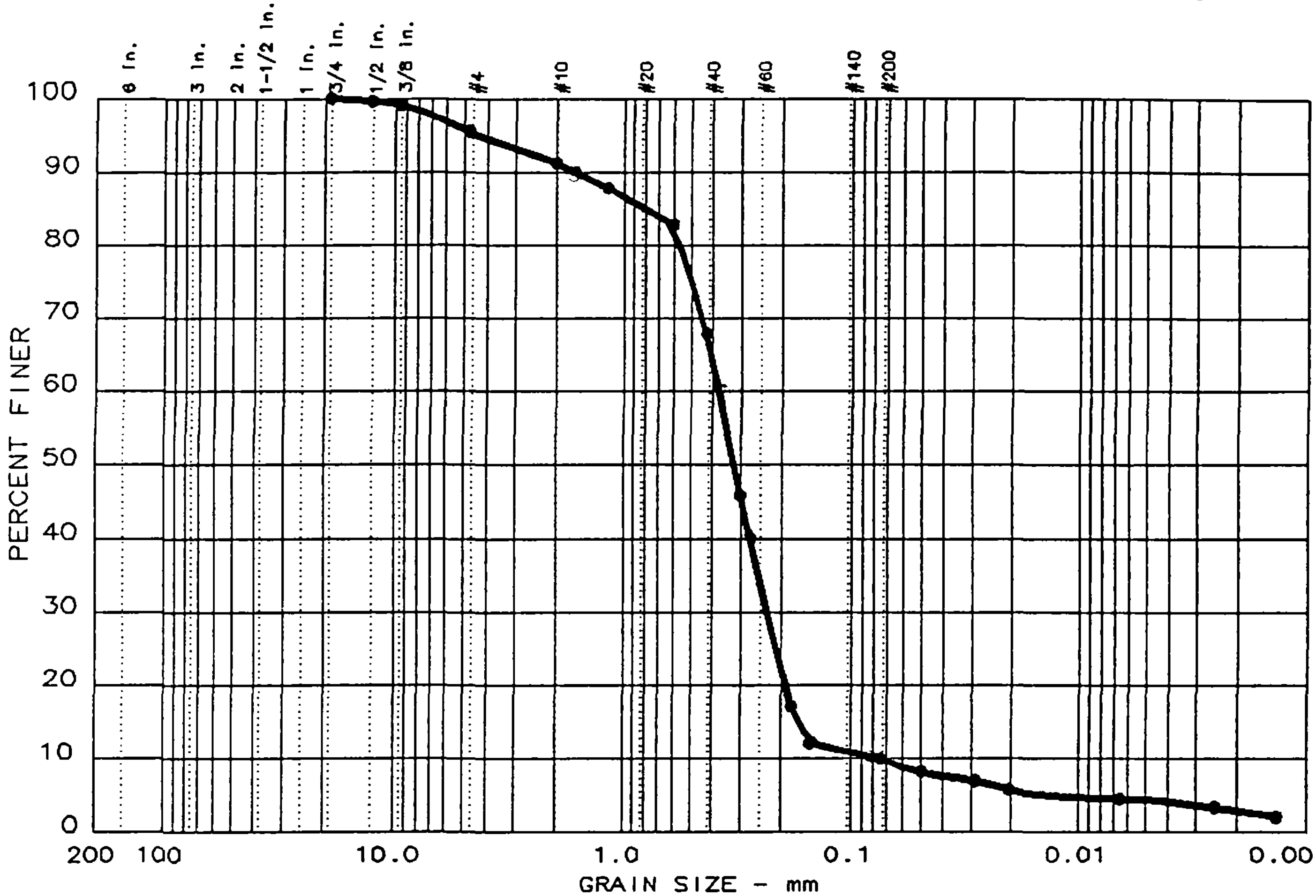
WELL DIAGRAM



APPENDIX C

Grain-Size Analytical Results

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	4.5	85.5	5.7	4.3

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	0.80	0.37	0.32	0.229	0.1656	0.0757	1.85	4.9

MATERIAL DESCRIPTION	USCS	AASHTO
● Black Fine-Coarse SAND, Trace Gr, Silt & Clay	SP-SM	

Project No.: C95112
Project: C10299.006 Rock Island
● Location: GM21 @ 13 to 15 ft

Date: 7/26/95

GRAIN SIZE DISTRIBUTION TEST REPORT

CGC, Inc.

Remarks:

TESTS BY: DWA

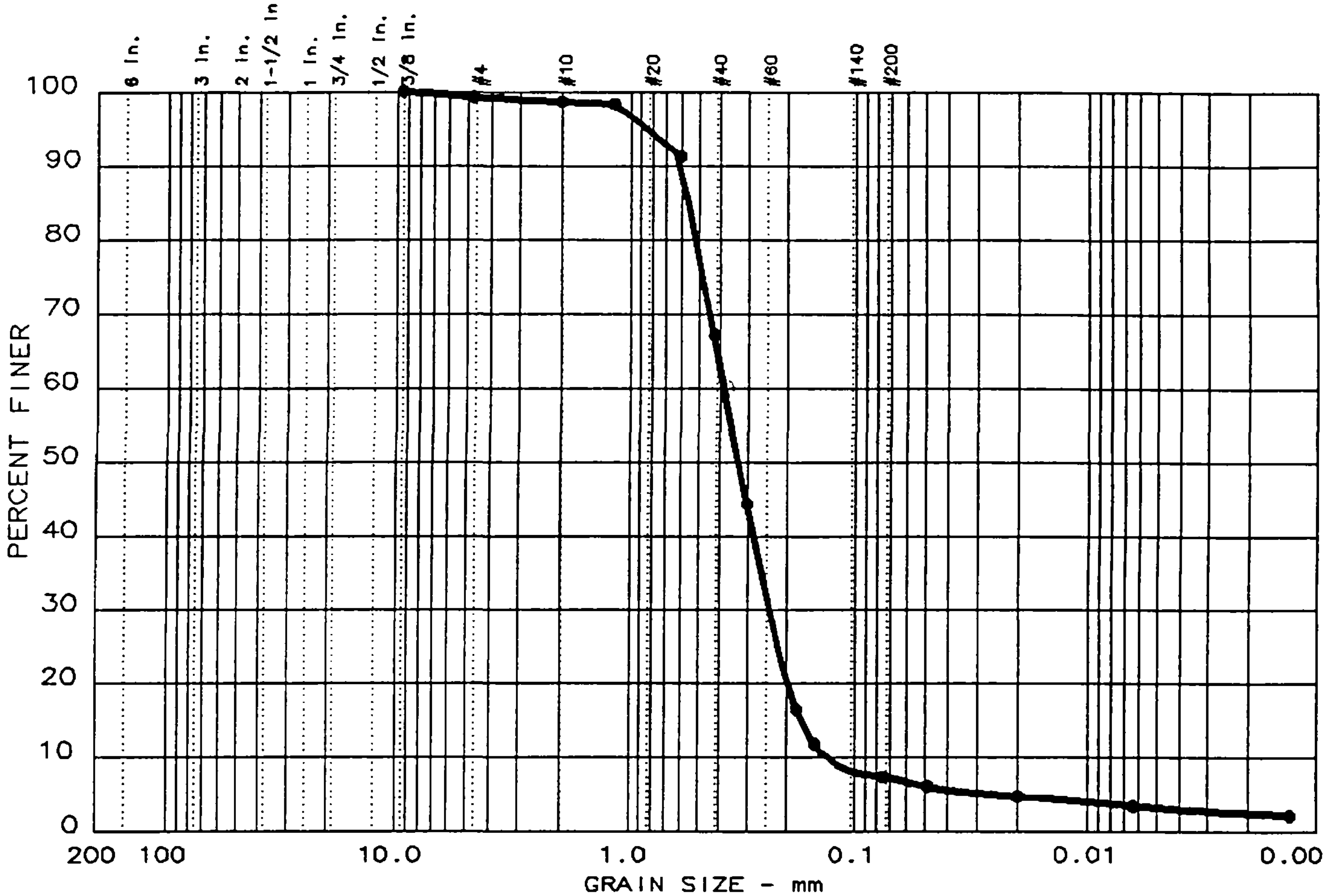
INPUT BY: MES

CHECKED BY: KJL

APPROVED BY: DWA

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.8	91.9	4.1	3.2

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	0.55	0.38	0.33	0.238	0.1722	0.1321	1.12	2.9

MATERIAL DESCRIPTION	USCS	AASHTO
● Black Fine-Medium SAND, Trace Silt, Clay & Gr	SP-SM	

Project No.: C95112

Project: C10299.006 Rock Island

● Location: GM21 @ 17 to 19 ft

Date: 7/26/95

GRAIN SIZE DISTRIBUTION TEST REPORT

CGC, Inc.

Remarks:

TESTS BY: DWA

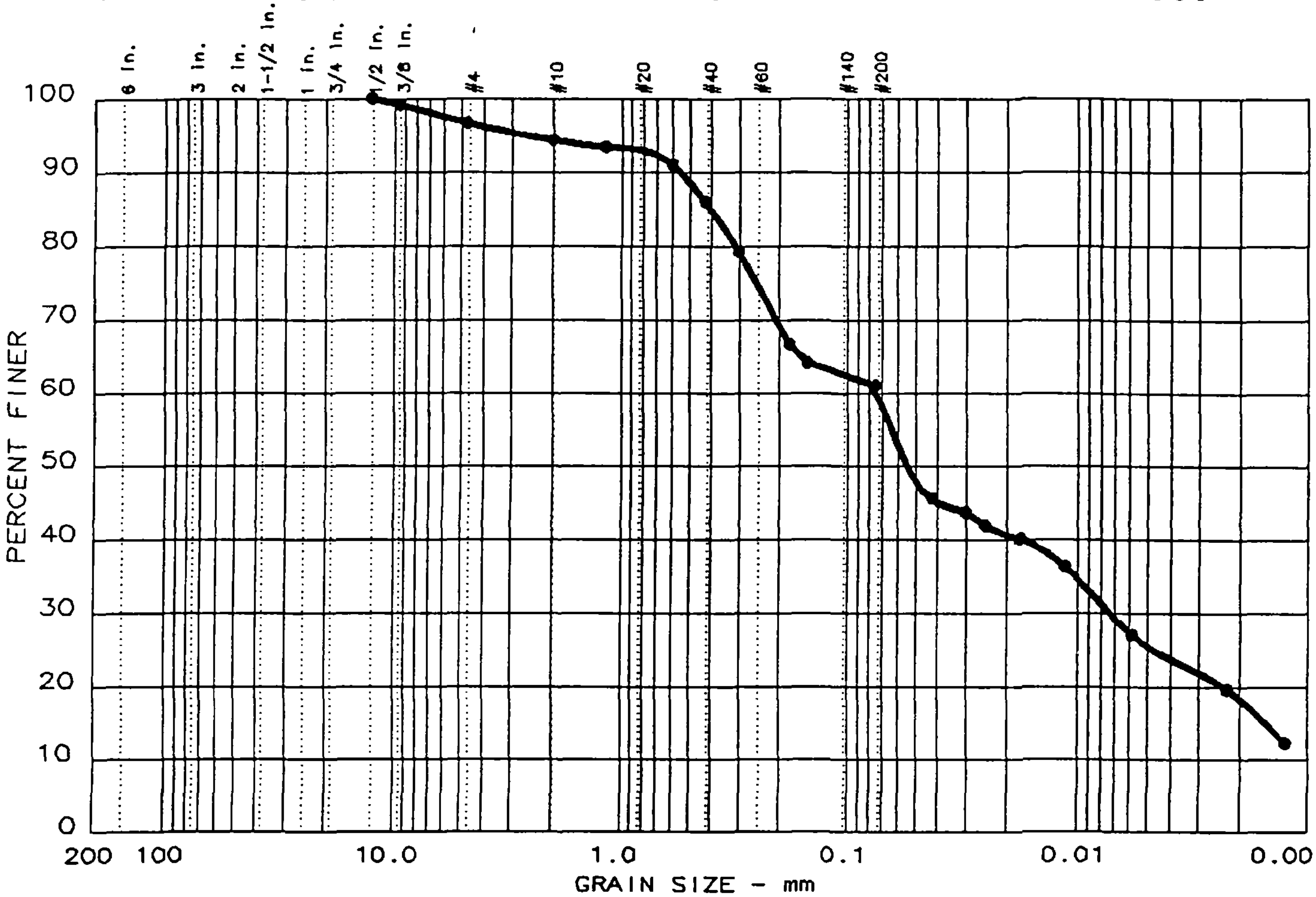
INPUT BY: MES

CHECKED BY: KJL

APPROVED BY: [signature]

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	3.4	35.5	35.6	25.5

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	-	-	0.398		0.054	0.007	0.0015			

MATERIAL DESCRIPTION	USCS	AASHTO
● Black Clayey SILT, Some Clay, Trace Gravel	ML	

Project No.: C95112
Project: C10299.006 Rock Island
● Location: GM21 @ 18 to 25 ft

Date: 7/26/95

GRAIN SIZE DISTRIBUTION TEST REPORT

CGC, Inc.

Remarks:

TESTS BY: DWA

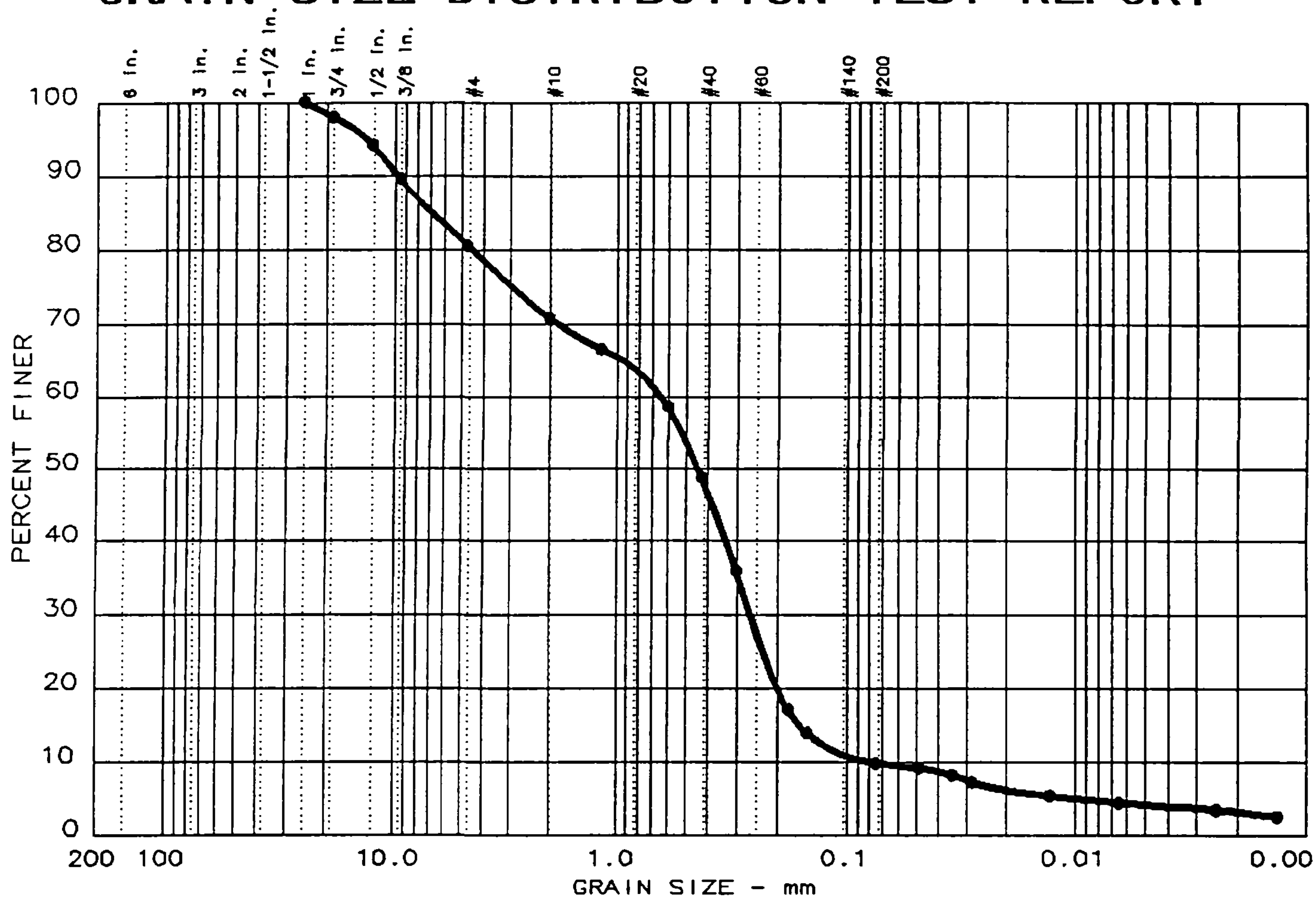
INPUT BY: MES

CHECKED BY: KJL

APPROVED BY: DWA

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	19.4	70.7	5.7	4.2

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	6.84	0.64	0.44	0.260	0.1601	0.0793	1.33	8.0

MATERIAL DESCRIPTION	USCS	AASHTO
● Gray-Black F-C SAND, Some Gr, Ltl Silt, Tr Clay	SW-SM	

Project No.: C95112
Project: C10299.006 Rock Island
● Location: GM21 @ 23 to 25 ft

Date: 7/26/95

GRAIN SIZE DISTRIBUTION TEST REPORT

CGC, Inc.

Remarks:

TESTS BY: DWA

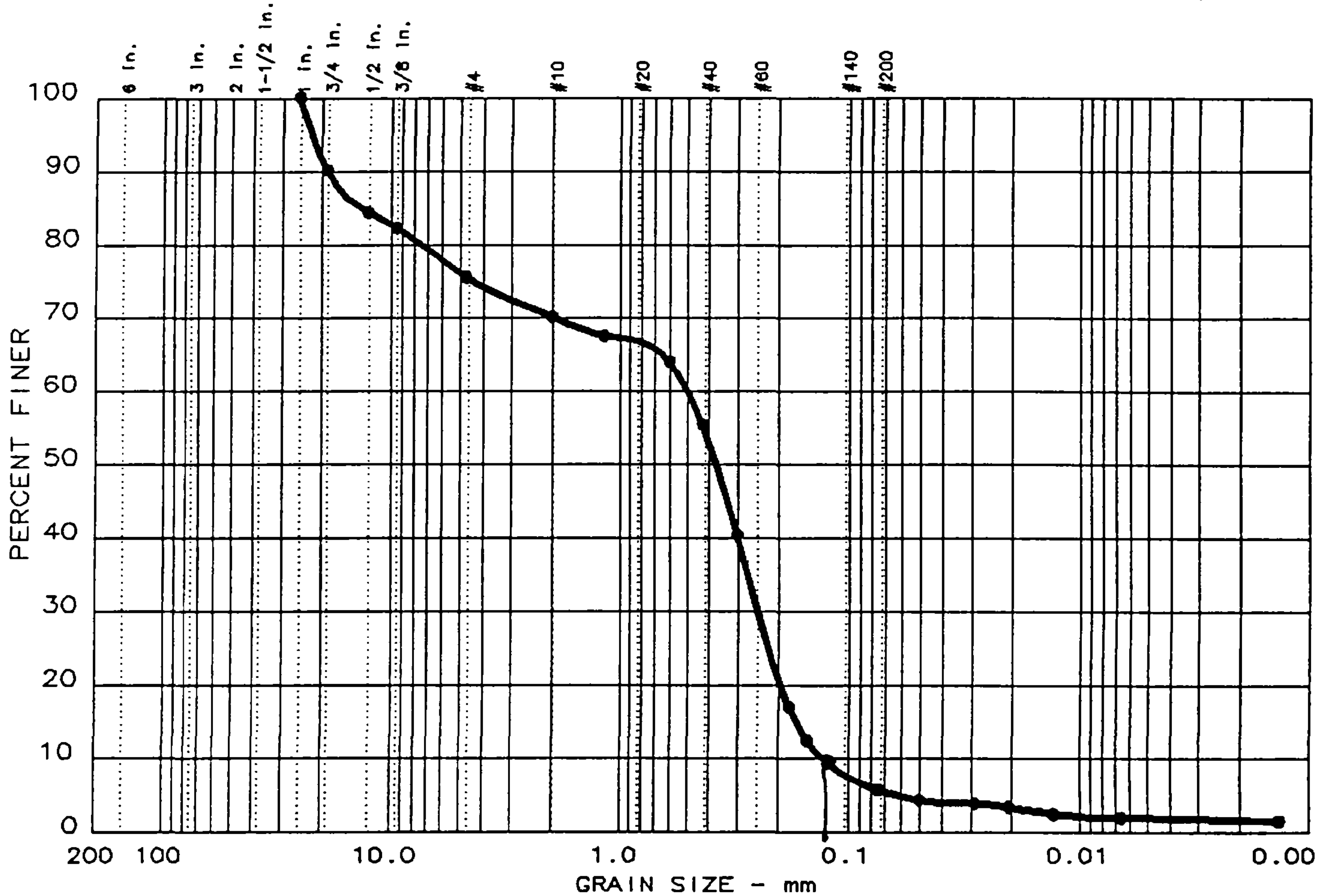
INPUT BY: MES

CHECKED BY: KJL

APPROVED BY: DWA

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	24.4	69.7	3.9	2.0

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	13.65	0.49	0.37	0.244	0.1667	0.1279	0.94	3.9

MATERIAL DESCRIPTION	USCS	AASHTO
● Black Fine-Coarse SAND, Some Gr, Tr Silt & Clay	SP-SM	

Project No.: C95112
Project: C10299.006 Rock Island
● Location: GM22 @ 12 to 14 ft

Date: 7/26/95

GRAIN SIZE DISTRIBUTION TEST REPORT

CGC, Inc.

Remarks:

TESTS BY: DWA

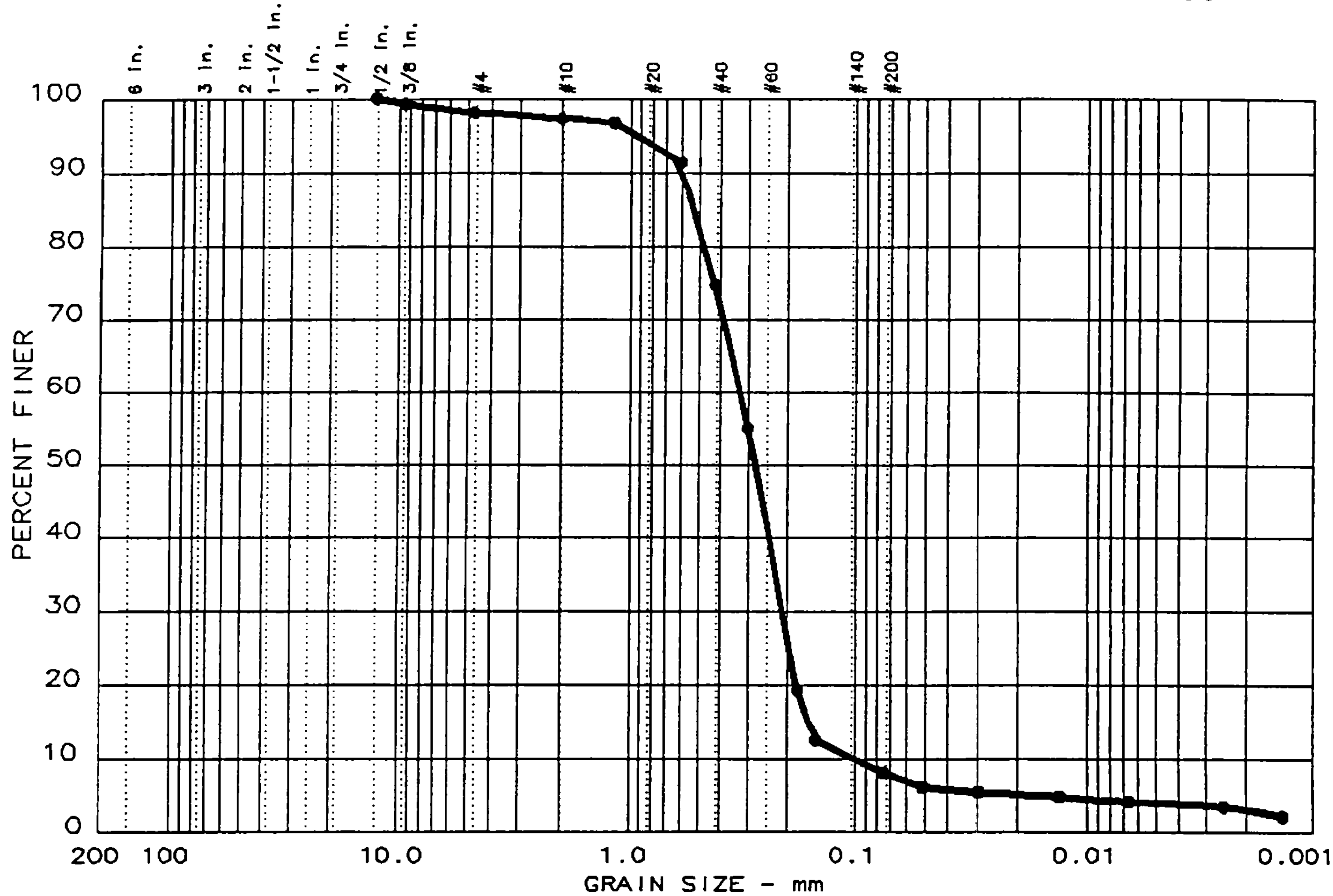
INPUT BY: MES

CHECKED BY: KJL

APPROVED BY: [signature]

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	1.9	90.0	4.1	4.0

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	0.52	0.32	0.28	0.209	0.1601	0.0999	1.36	3.2

MATERIAL DESCRIPTION	USCS	AASHTO
● Black Fine-Coarse SAND, Trace Silt, Gr & Clay	SP-SM	

Project No.: C95112
Project: C10299.006 Rock Island
● Location: GM22 @ 16 to 18 ft

Date: 7/26/95

GRAIN SIZE DISTRIBUTION TEST REPORT

CGC, Inc.

Remarks:

TESTS BY: DWA

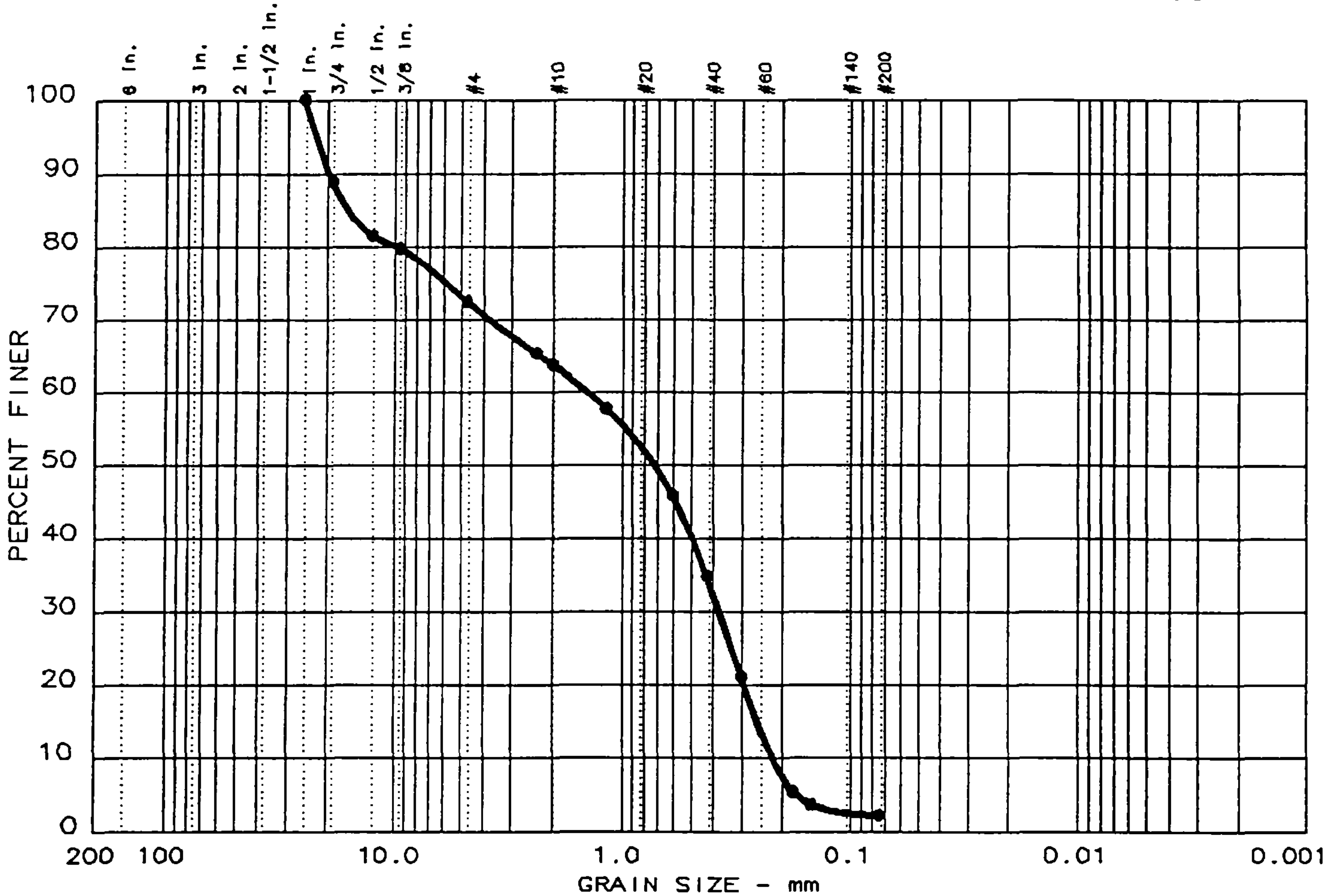
INPUT BY: MES

CHECKED BY: KJL

APPROVED BY: DWA

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	27.5	70.2	2.3	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	16.22	1.41	0.72	0.374	0.2553	0.2198	0.45	6.4

MATERIAL DESCRIPTION	USCS	AASHTO
● Gray Fine-Coarse SAND, Some Gravel, Trace Clay	SP	

Project No.: C95112
Project: C10299.006 Rock Island
● Location: GM22 @ 22 to 24 ft

Date: 7/26/95

GRAIN SIZE DISTRIBUTION TEST REPORT

CGC, Inc.

Remarks:

TESTS BY: DWA

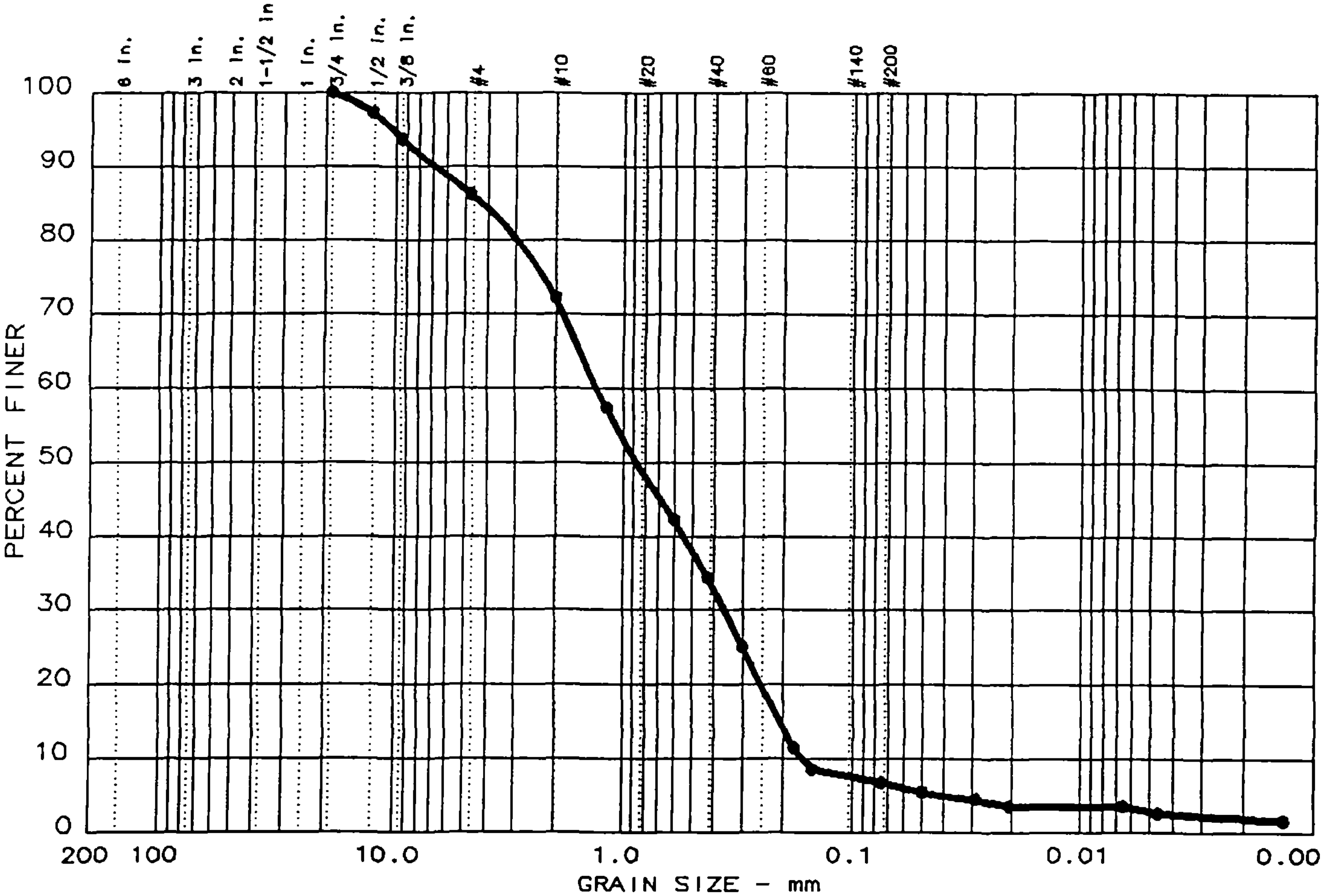
INPUT BY: MES

CHECKED BY: KJL

APPROVED BY: [signature]

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	13.9	79.4	4.0	2.7

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	4.22	1.30	0.87	0.357	0.2068	0.1642	0.60	7.9

MATERIAL DESCRIPTION	USCS	AASHTO
● Black Fine-Coarse SAND, So Gr, Tr Silt & Clay	SP-SM	

Project No.: C95112
Project: C10299.006 Rock Island
● Location: GM20D @ 13 to 15 ft

Date: 7/26/95

GRAIN SIZE DISTRIBUTION TEST REPORT

CGC, Inc.

Remarks:

TESTS BY: DWA

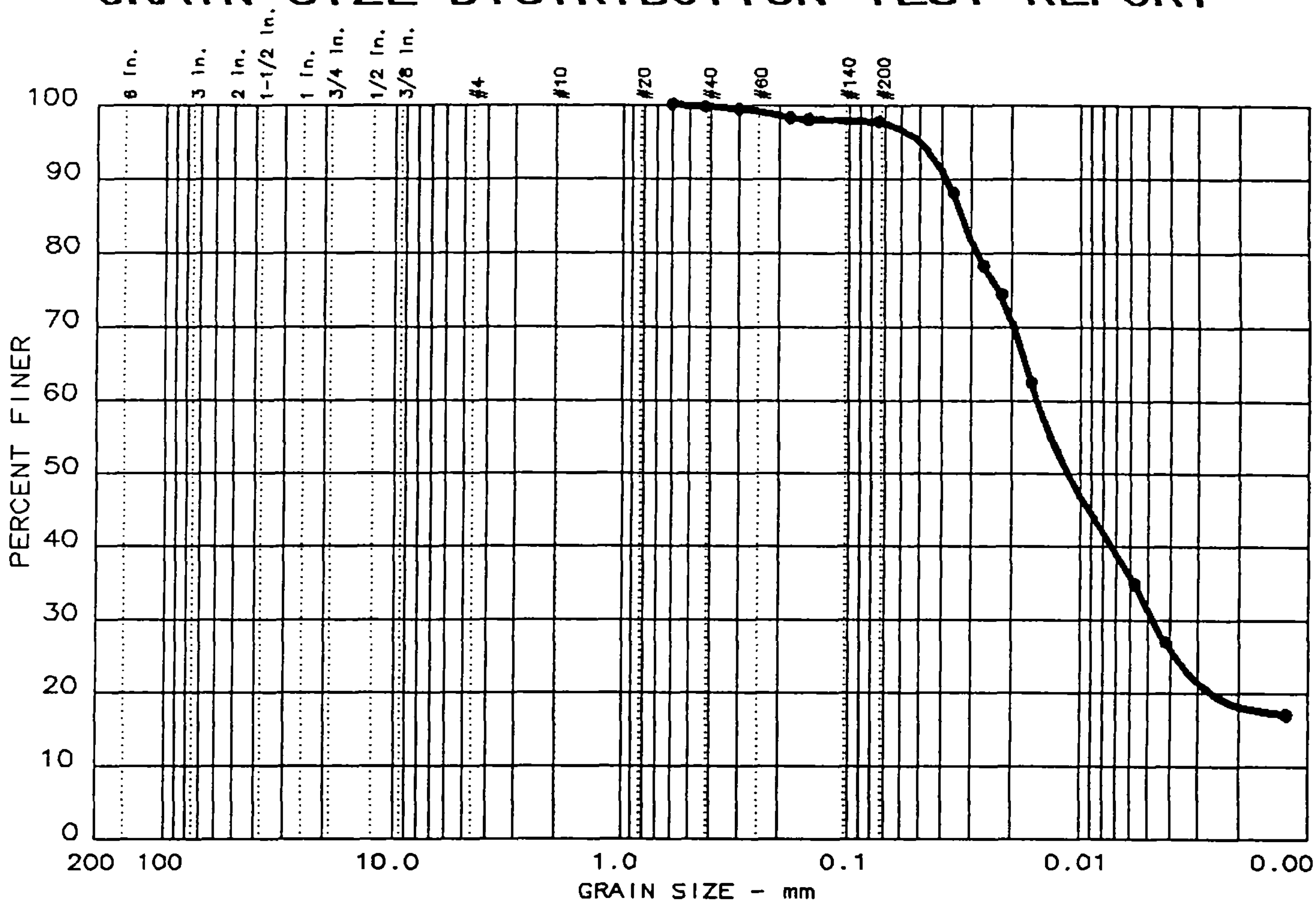
INPUT BY: MES

CHECKED BY: KJL

APPROVED BY: DWA

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	2.3	66.4	31.3

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	-	-			0.011	0.005				

MATERIAL DESCRIPTION	USCS	AASHTO
● Gray-Black Lean CLAY, Trace Sand	CL	

Project No.: C95112
Project: C10299.006 Rock Island
● Location: GM20D @ 17 to 19 ft

Date: 7/26/95

GRAIN SIZE DISTRIBUTION TEST REPORT

CGC, Inc.

Remarks:

TESTS BY: DWA

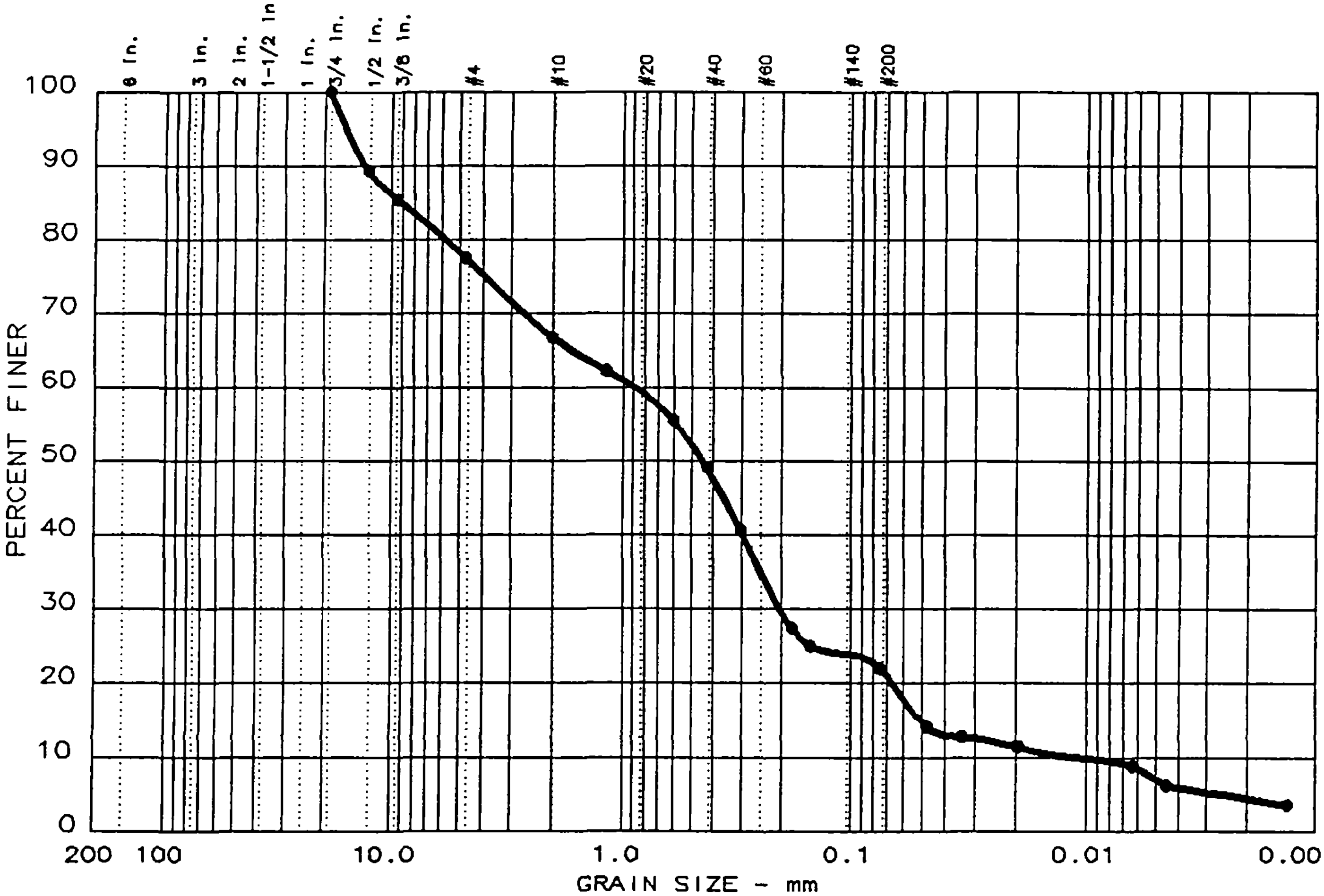
INPUT BY: MES

CHECKED BY: KJL

APPROVED BY: DWA

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	22.6	55.4	15.0	7.0

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	9.12	0.88	0.44	0.204	0.0507	0.0099	4.79	89.1

MATERIAL DESCRIPTION	USCS	AASHTO
● Gray Fine-Coarse SAND, Some Silt & Gr, Ltl Clay	SM	

Project No.: C95112
Project: C10299.006 Rock Island
● Location: GM20D @ 19 to 21 ft

Date: 7/26/95

GRAIN SIZE DISTRIBUTION TEST REPORT

CGC, Inc.

Remarks:

TESTS BY: DWA

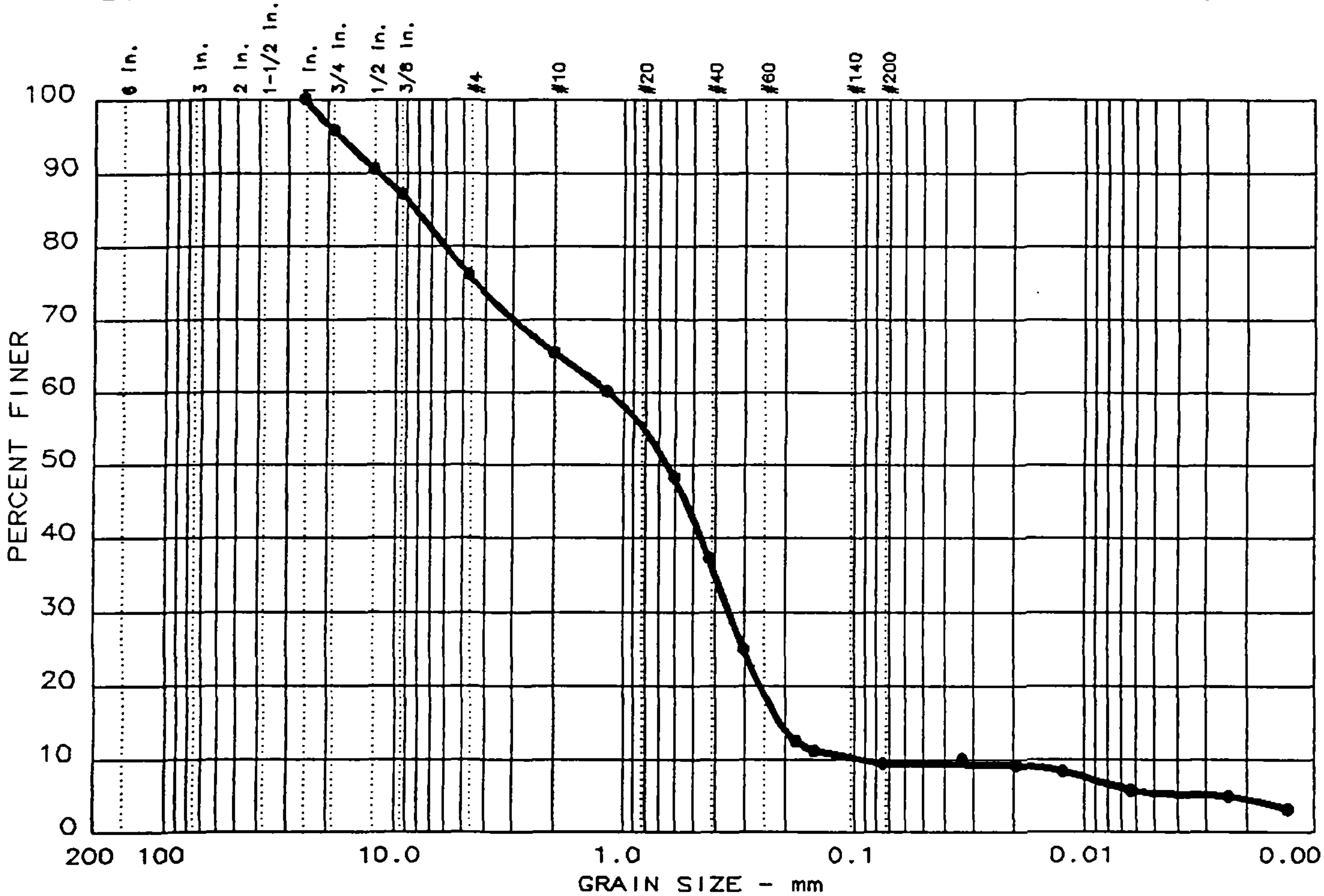
INPUT BY: MES

CHECKED BY: KJL

APPROVED BY: DWA

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	23.8	66.7	4.1	5.4

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	8.13	1.16	0.64	0.346	0.2084	0.0920	1.12	12.6

MATERIAL DESCRIPTION	USCS	AASHTO
● Gray F-C SAND, Some Gravel, Trace Si & Cl	SW-SM	

Project No.: C95112
Project: C10299.006 Rock Island
● Location: GM20D @ 21 to 23 ft

Date: 7/26/95

GRAIN SIZE DISTRIBUTION TEST REPORT

CGC, Inc.

Remarks:

TESTS BY: DWA

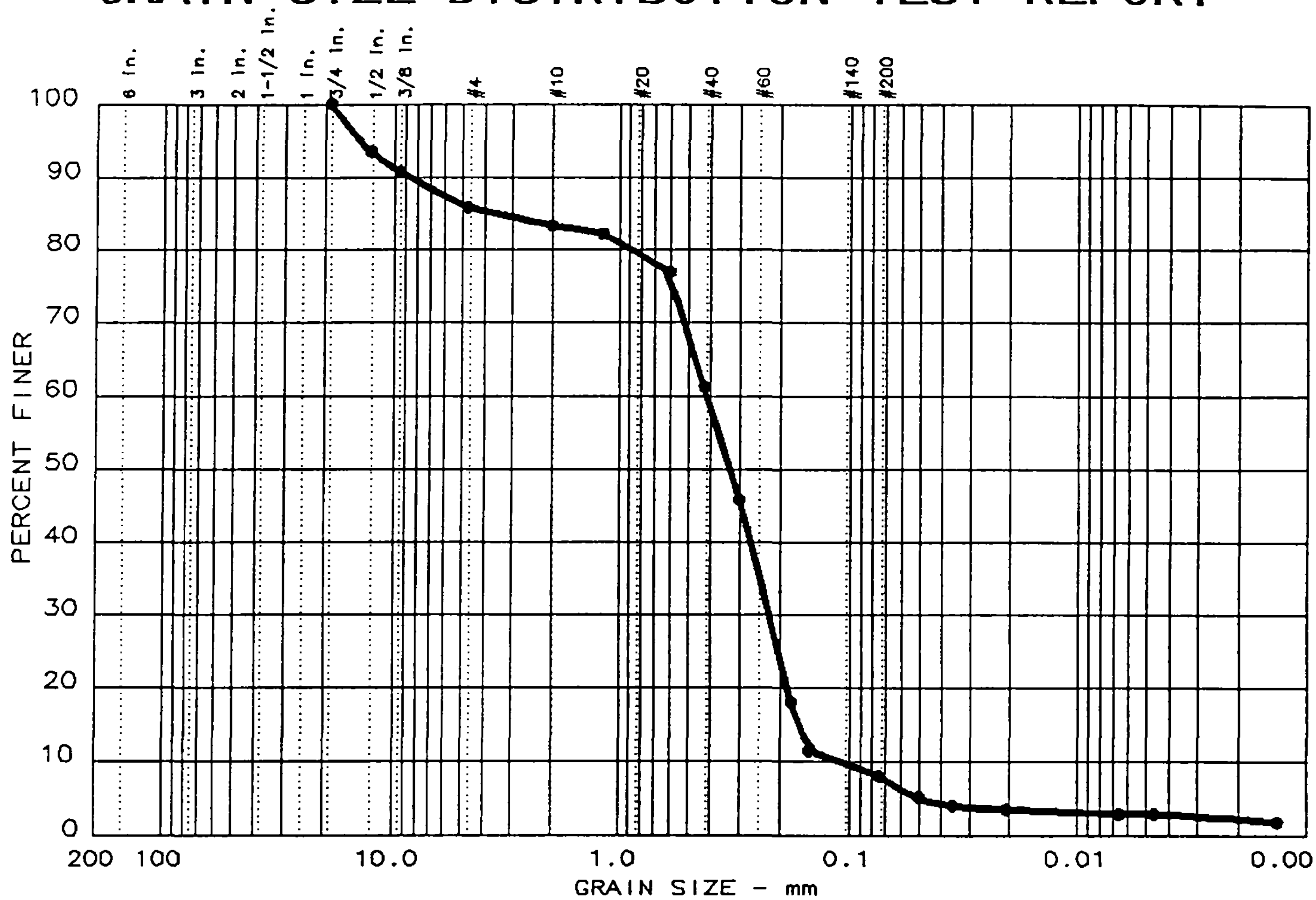
INPUT BY: MES

CHECKED BY: KJL

APPROVED BY: DWA

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	14.2	77.7	5.1	3.0

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	3.59	0.41	0.33	0.222	0.1656	0.1107	1.08	3.7

MATERIAL DESCRIPTION	USCS	AASHTO
● Black F-C SAND, Some Bravel, Trace Si & Cl	SP-SM	

Project No.: C95112
Project: C10299.006 Rock Island
● Location: GM25D @ 15 to 17 ft

Date: 7/26/95

GRAIN SIZE DISTRIBUTION TEST REPORT

CGC, Inc.

Remarks:

TESTS BY: DWA

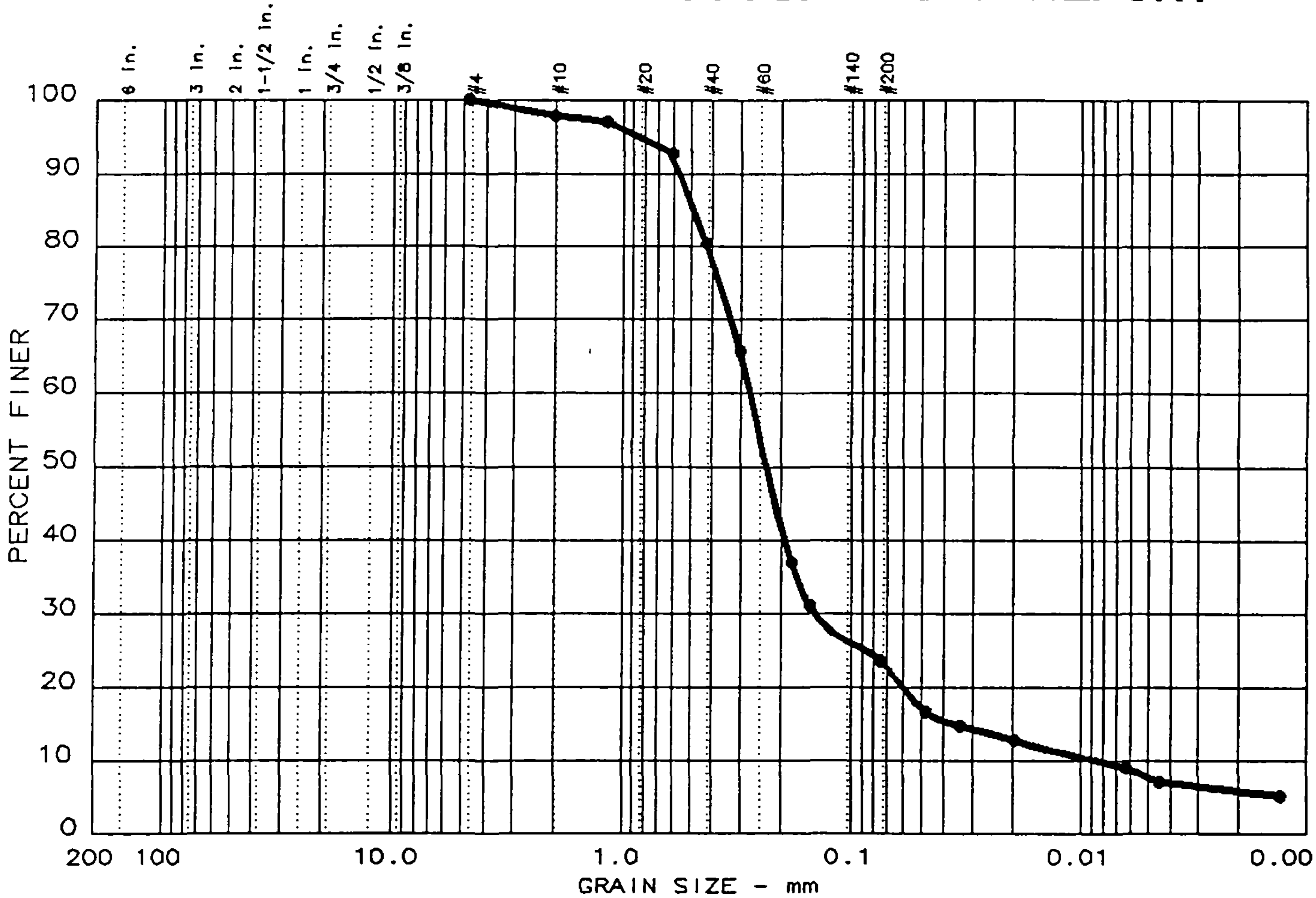
INPUT BY: MES

CHECKED BY: KJL

APPROVED BY:

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	76.4	15.9	7.7

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	0.48	0.27	0.23	0.141	0.0363	0.0084	8.76	32.2

MATERIAL DESCRIPTION	USCS	AASHTO
● Black F-C SAND, Little Silt, Trace Clay	SM	

Project No.: C95112
Project: C10299.006 Rock Island
● Location: GM25D @ 17 to 19 ft

Date: 7/26/95

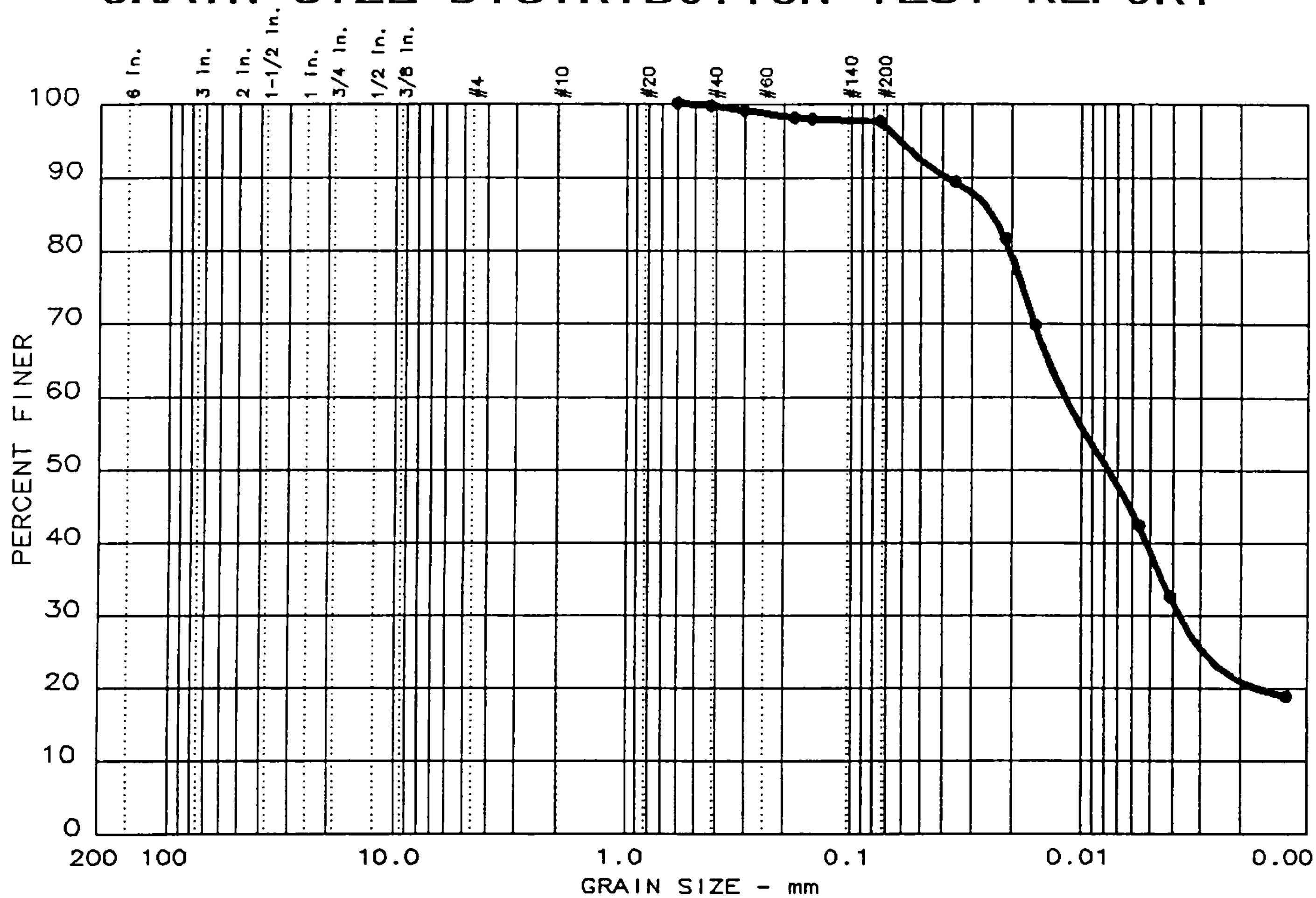
Remarks:
TESTS BY: DWA
INPUT BY: MES
CHECKED BY: KJL
APPROVED BY: DWG

GRAIN SIZE DISTRIBUTION TEST REPORT

CGC, Inc.

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	2.4	58.7	38.9

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	—	—			0.008	0.004				

MATERIAL DESCRIPTION	USCS	AASHTO
● Gray-Black Lean CLAY, Trace Sand	CL	

Project No.: C95112
Project: C10299.006 Rock Island
● Location: GM25D @ 19 to 21 ft

Date: 7/26/95

GRAIN SIZE DISTRIBUTION TEST REPORT

CGC, Inc.

Remarks:

TESTS BY: DWA

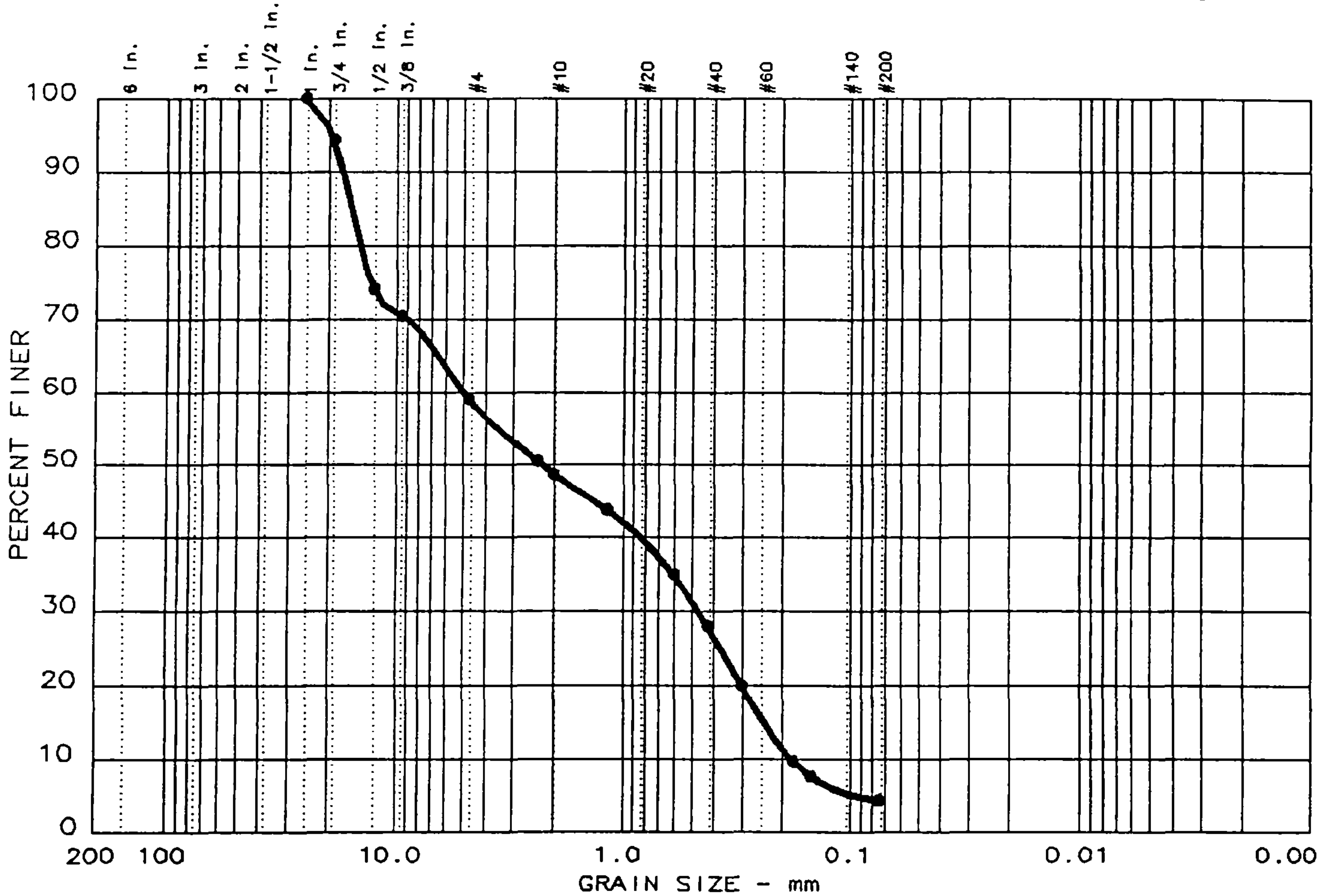
INPUT BY: MES

CHECKED BY: KJL

APPROVED BY: DWA

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	40.9	54.8	4.3	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	15.85	4.95	2.24	0.467	0.2396	0.1818	0.24	27.3

MATERIAL DESCRIPTION	USCS	AASHTO
● Gray F-C SAND & GRAVEL, Trace Silt	SP	

Project No.: C95112
Project: C10299.006 Rock Island
● Location: GM25D @ 25 to 27 ft

Date: 7/26/95

GRAIN SIZE DISTRIBUTION TEST REPORT

CGC, Inc.

Remarks:

TESTS BY: DWA

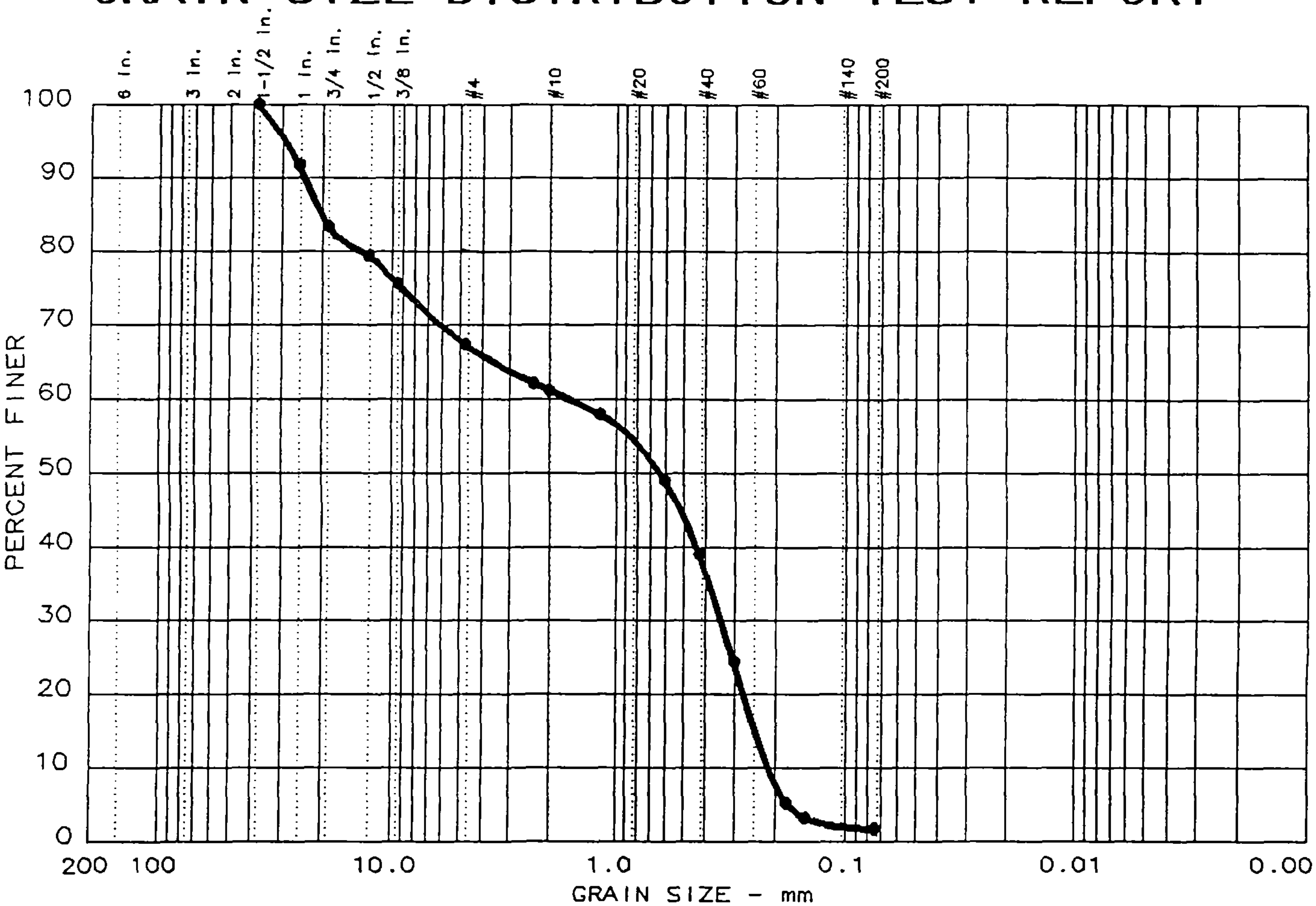
INPUT BY: MES

CHECKED BY: KJL

APPROVED BY: [signature]

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	32.7	65.5	1.8	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	20.32	1.65	0.63	0.339	0.2429	0.2140	0.33	7.7

MATERIAL DESCRIPTION	USCS	AASHTO
● Gray F-C SAND & GRAVEL, Trace Silt	SP	

Project No.: C95112
Project: C10299.006 Rock Island
● Location: **GM25D @ 23 to 25 ft**

Date: 7/26/95

GRAIN SIZE DISTRIBUTION TEST REPORT

CGC, Inc.

Remarks:

TESTS BY: DWA

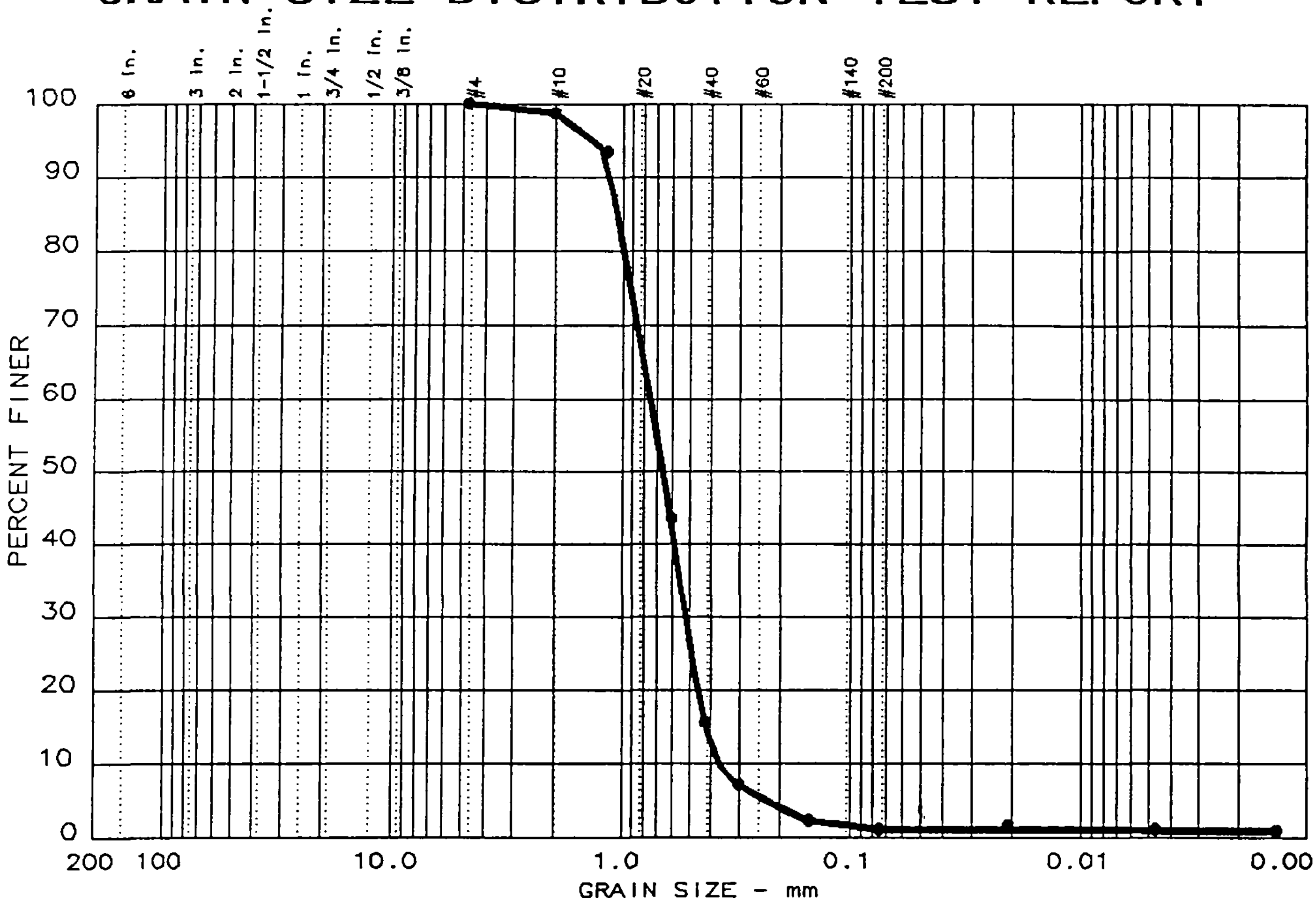
INPUT BY: MES

CHECKED BY: KJL

APPROVED BY: DWA

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	98.9	0.1	1.0

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	1.05	0.75	0.65	0.518	0.4193	0.3648	0.98	2.0

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown Fine-Coarse SAND, Trace Silt & Clay	SP	

Project No.: C95112
Project: C10299.006 Rock Island
● Location: GM23D @ 34 to 36 ft

Date: 8/3/95

GRAIN SIZE DISTRIBUTION TEST REPORT

CGC, Inc.

Remarks:

TESTS BY: DWA

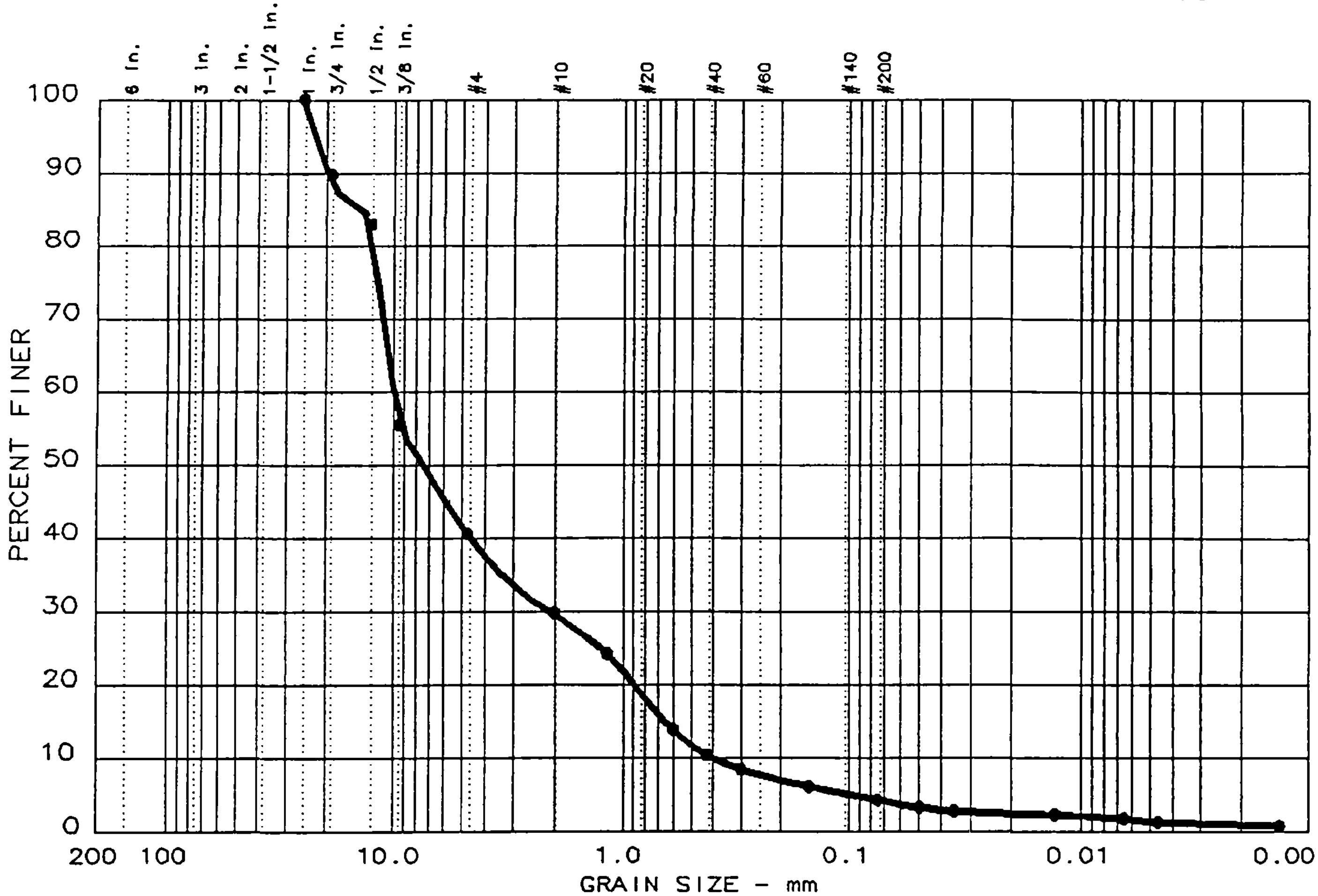
INPUT BY: MES

CHECKED BY: KJL

APPROVED BY:

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	59.4	36.3	2.9	1.4

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	13.96	9.98	7.31	2.061	0.6442	0.3972	1.07	25.1

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown Fine-Coarse SAND & GRAVEL, Tr Silt & Clay	GW	

Project No.: C95112
Project: C10299.006 Rock Island
● Location: GM23D @ 36 to 38 ft

Date: 8/3/95

GRAIN SIZE DISTRIBUTION TEST REPORT

CGC, Inc.

Remarks:

TESTS BY: DWA

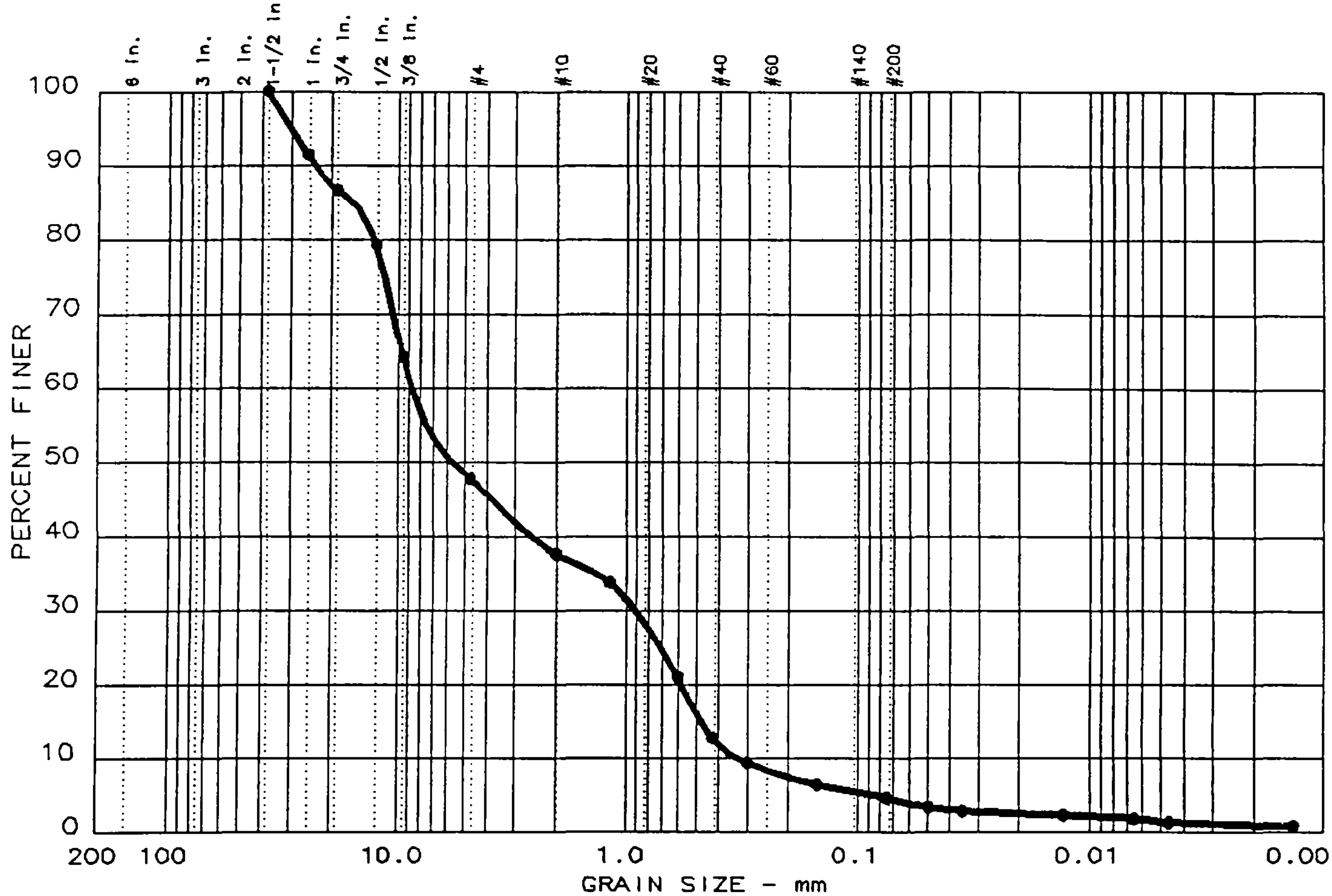
INPUT BY: MES

CHECKED BY: KJL

APPROVED BY:

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	52.2	43.1	3.2	1.5

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	16.22	8.65	5.65	0.895	0.4742	0.3319	0.28	26.1

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown Fine-Coarse SAND & GRAVEL, Tr Silt & Clay	GP	

Project No.: C95112
Project: C10299.006 Rock Island
● Location: GM23D @ 38 to 40 ft

Date: 8/3/95

GRAIN SIZE DISTRIBUTION TEST REPORT

CGC, Inc.

Remarks:

TESTS BY: DWA

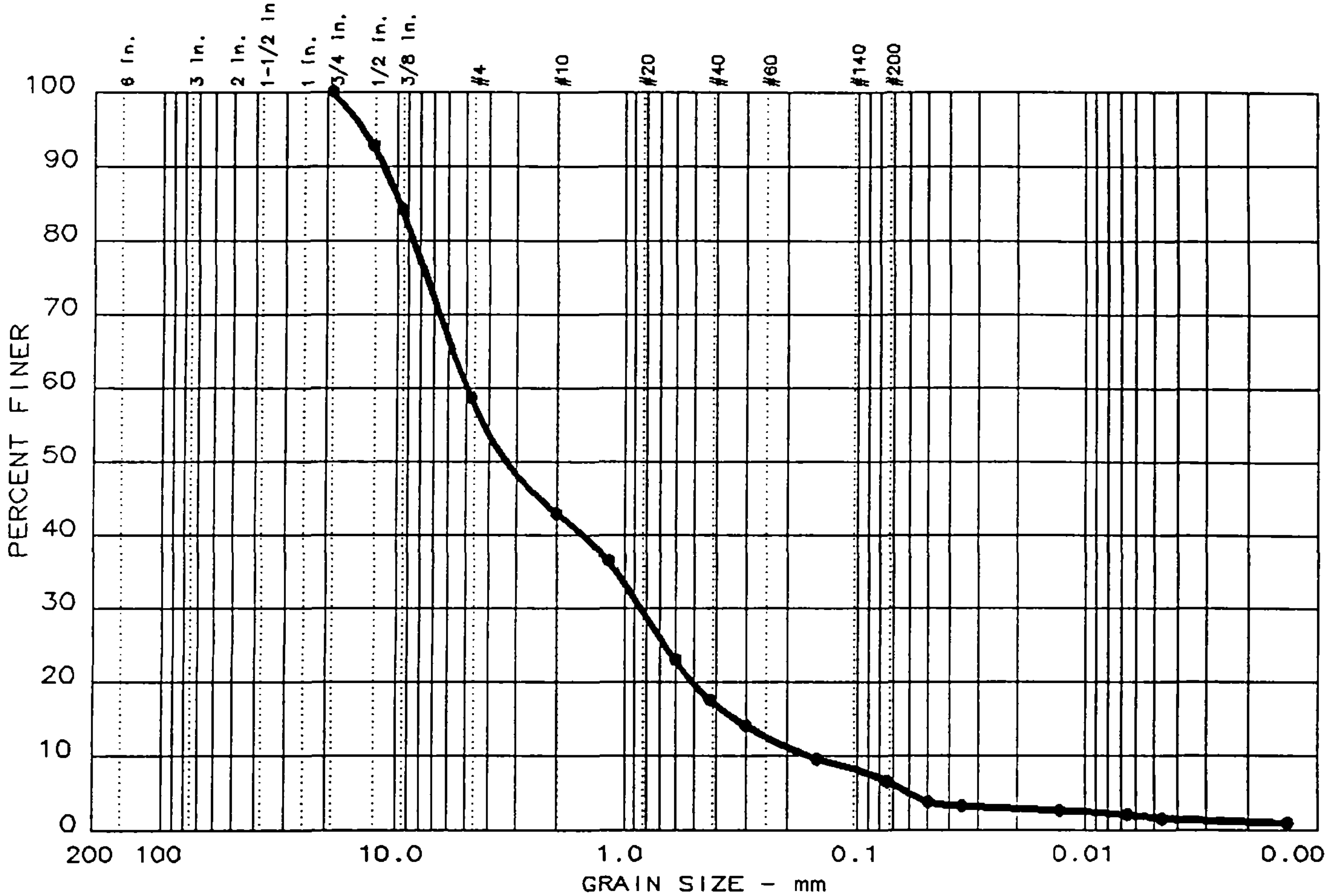
INPUT BY: MES

CHECKED BY: KJL

APPROVED BY: DWA

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	41.3	52.1	4.9	1.7

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	9.75	4.94	3.30	0.839	0.3342	0.1637	0.87	30.2

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown Fine-Coarse SAND & GRAVEL, Tr Silt & Clay	SP-SM	

Project No.: C95112
Project: C10299.006 Rock Island
● Location: GM23D @ 40 to 42 ft

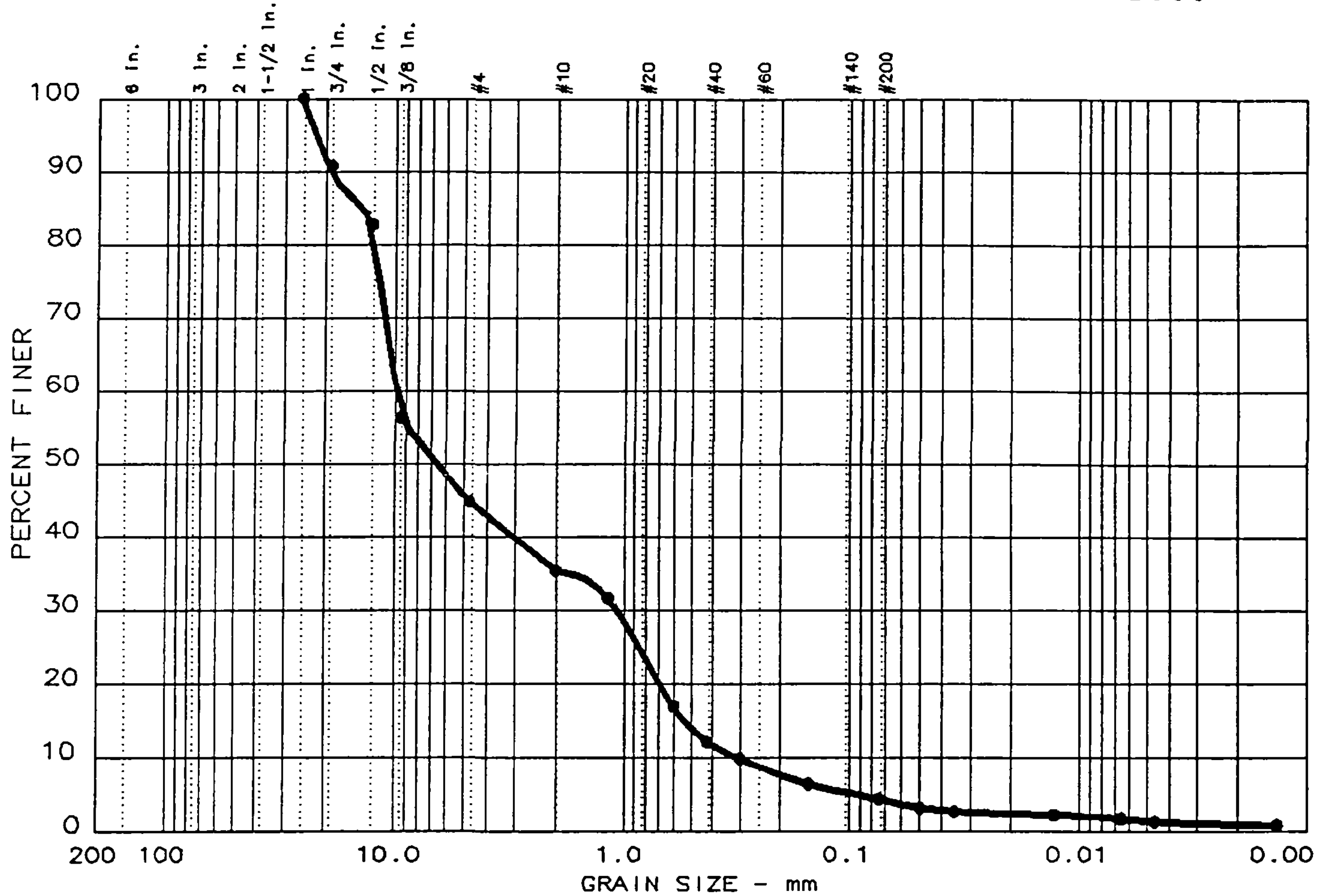
Date: 8/3/95

GRAIN SIZE DISTRIBUTION TEST REPORT
CGC, Inc.

Remarks:
TESTS BY: DWA
INPUT BY: MES
CHECKED BY: KJL
APPROVED BY:

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	55.2	40.5	3.0	1.3

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	13.80	9.91	6.47	1.062	0.5321	0.3097	0.37	32.0

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown Fine-Coarse SAND & GRAVEL, Tr Silt & Clay	GP	

Project No.: C95112
Project: C10299.006 Rock Island
● Location: GM23D @ 42 to 44 ft

Date: 8/3/95

GRAIN SIZE DISTRIBUTION TEST REPORT

CGC, Inc.

Remarks:

TESTS BY: DWA

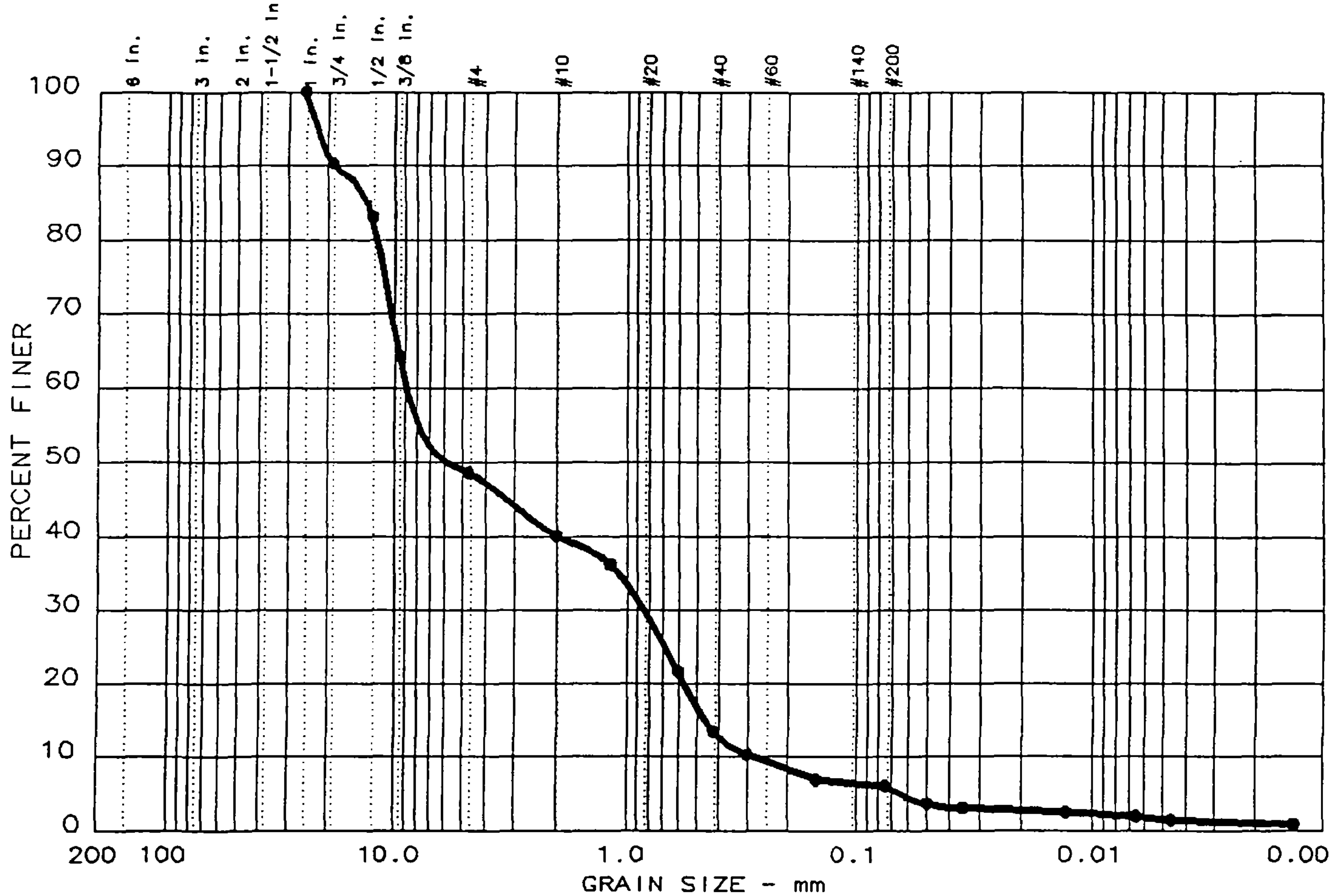
INPUT BY: MES

CHECKED BY: KJL

APPROVED BY: [signature]

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	51.4	42.5	4.6	1.5

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	13.34	8.81	5.89	0.832	0.4618	0.2848	0.28	30.9

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown Fine-Coarse SAND & GRAVEL, Tr Silt & Clay	GP-GM	

Project No.: C95112
Project: C10299.006 Rock Island
● Location: GM23D @ 49 to 51 ft

Date: 8/3/95

GRAIN SIZE DISTRIBUTION TEST REPORT

CGC, Inc.

Remarks:
TESTS BY: DWA
INPUT BY: MES
CHECKED BY: KJL
APPROVED BY: DWA

Figure No. 1

APPENDIX D

Upper Fill Unit Pumping Test Analysis and Drawdown Curves

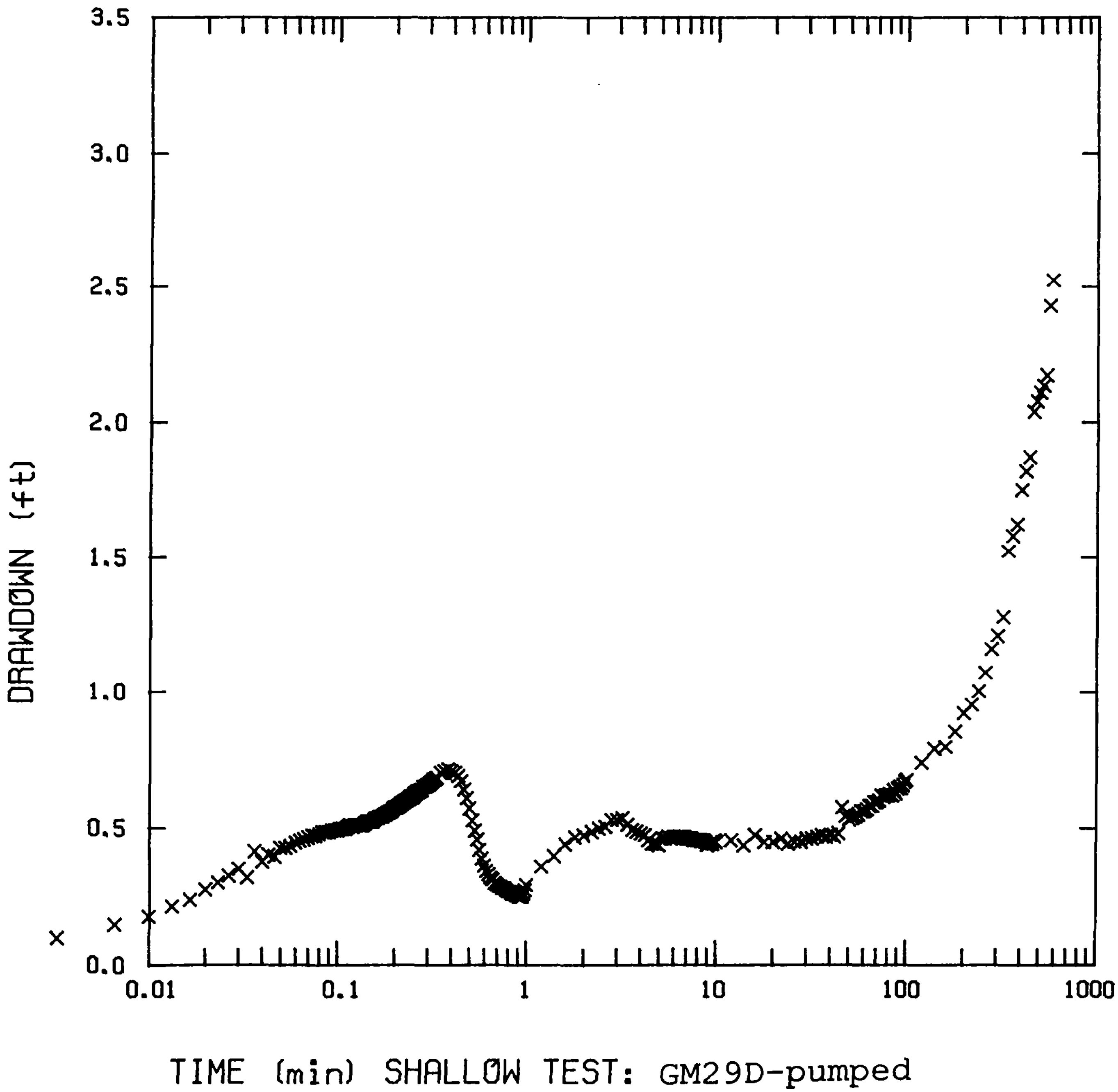

3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
DRAWDOWN (ft)
0.01
0.1
1
10
100
1000
TIME (min) SHALLOW TEST: GM29D-pumped

FIGURE D-1

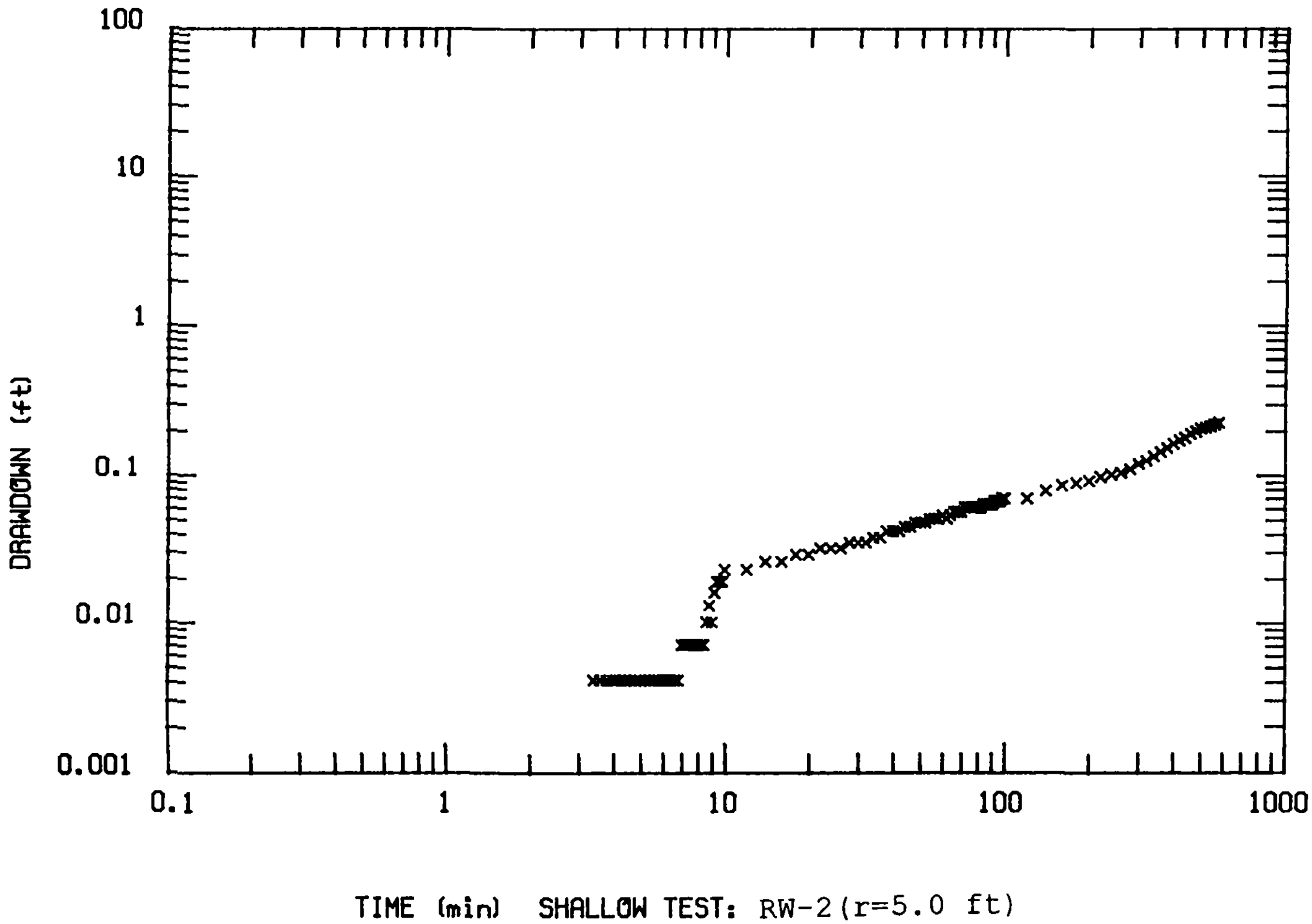
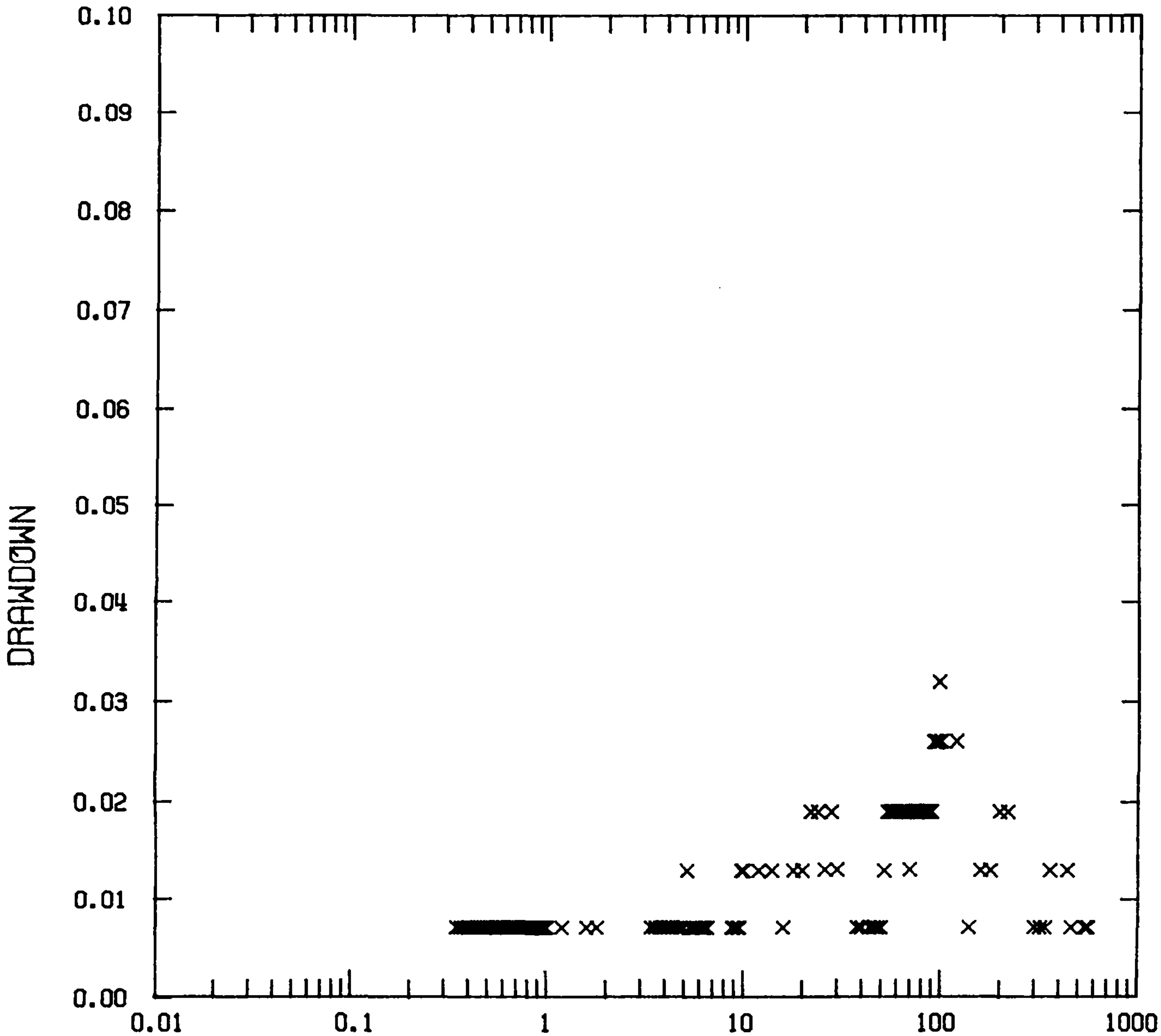
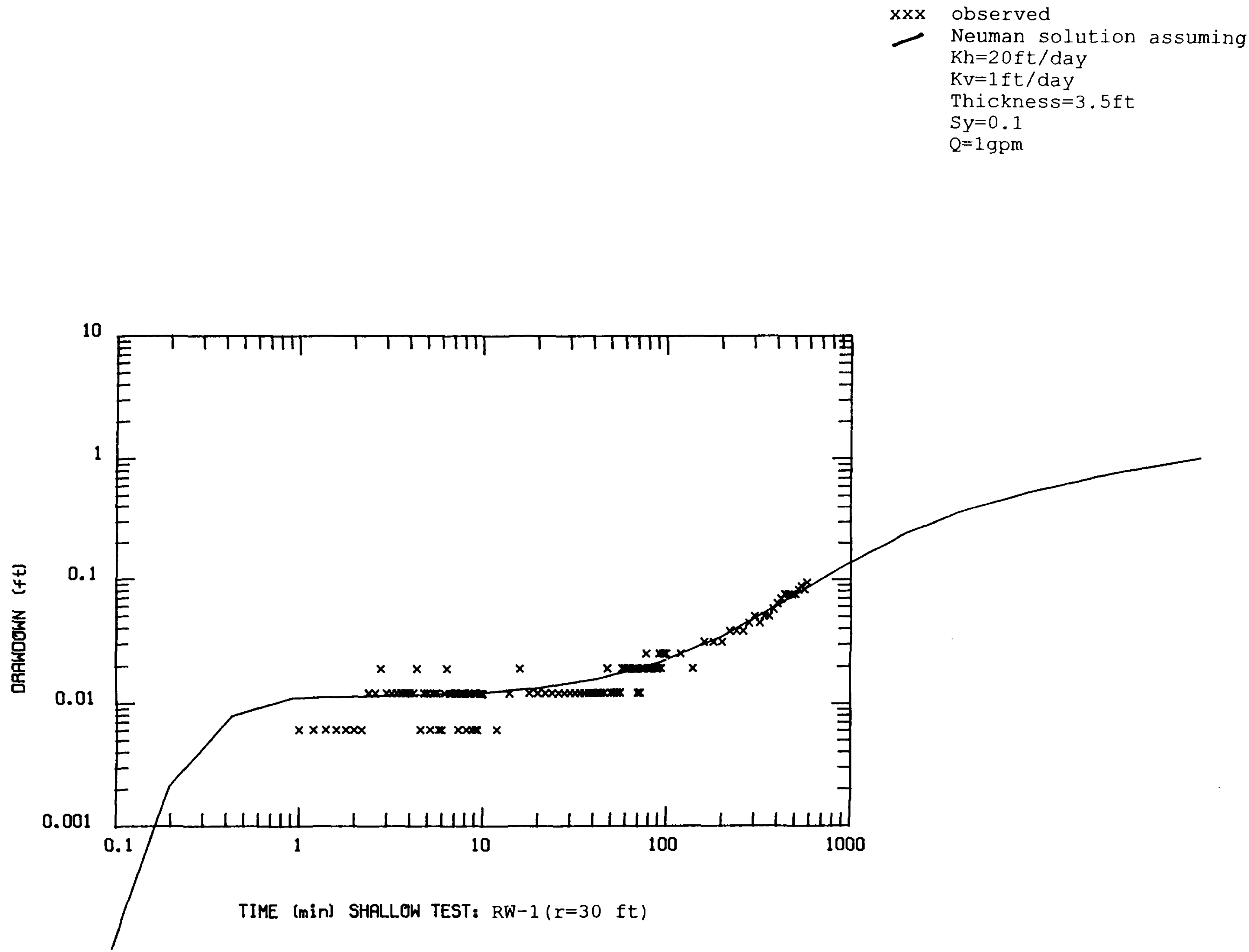

100
10
1
0.1
0.01
0.001
DRAWDOWN (ft)
0.1
1
10
100
1000
TIME (min) SHALLOW TEST: RW-2(r=5.0 ft)

FIGURE D-2



TIME (min) SHALLOW TEST: GM29D (r=4 ft)



xxx observed
Neuman solution assuming
Kh=20ft/day
Kv=1ft/day
Thickness=3.5ft
Sy=0.1
Q=1gpm
10
1
0.1
0.01
0.001
0.1
1
10
100
1000
DRAWDOWN (ft)
TIME (min) SHALLOW TEST: RW-1(r=30 ft)

APPENDIX E

Lower Sand and Gravel Unit Drawdown Curves

Deep Test

Q=75gpm
Deep Well

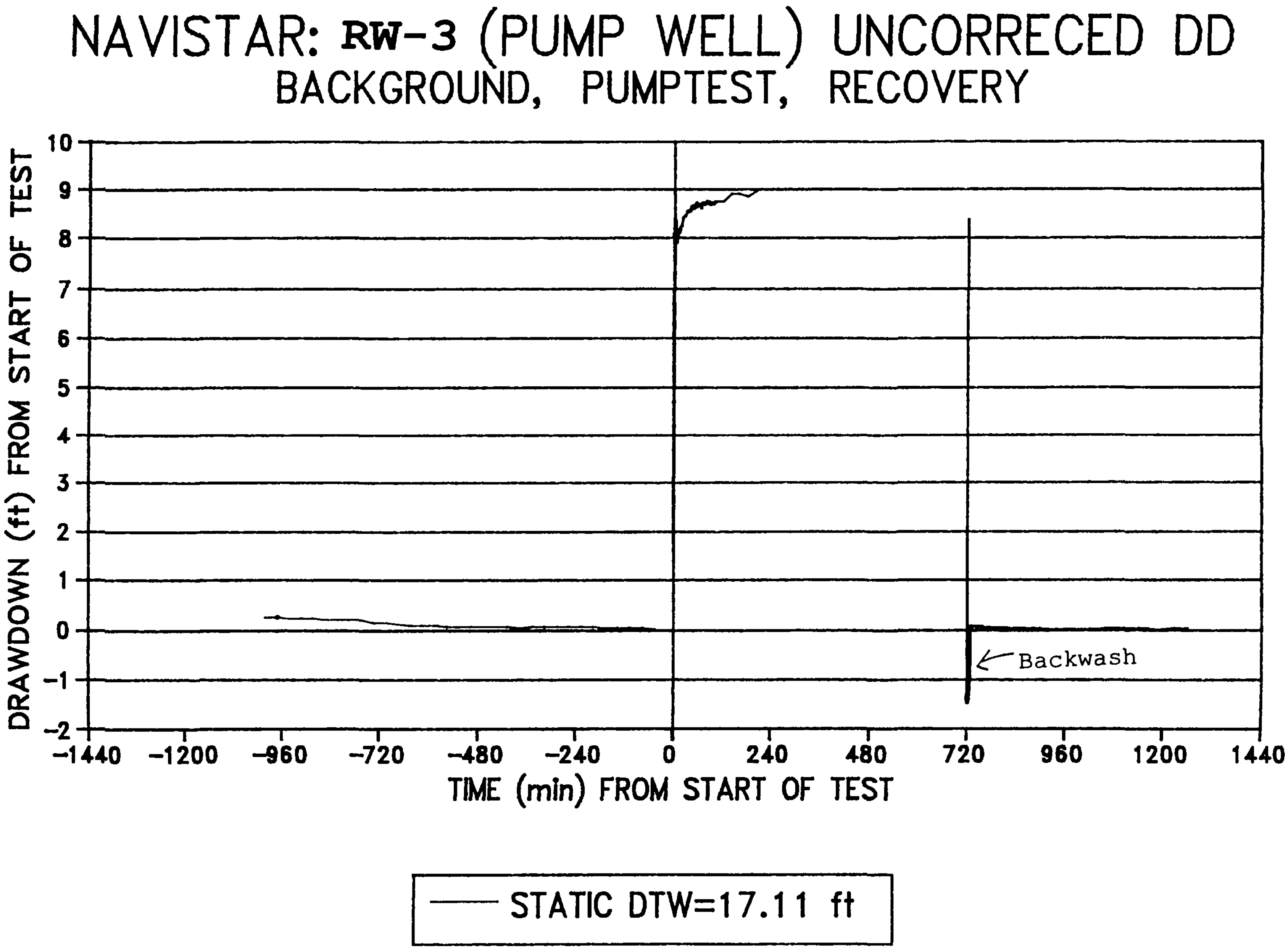
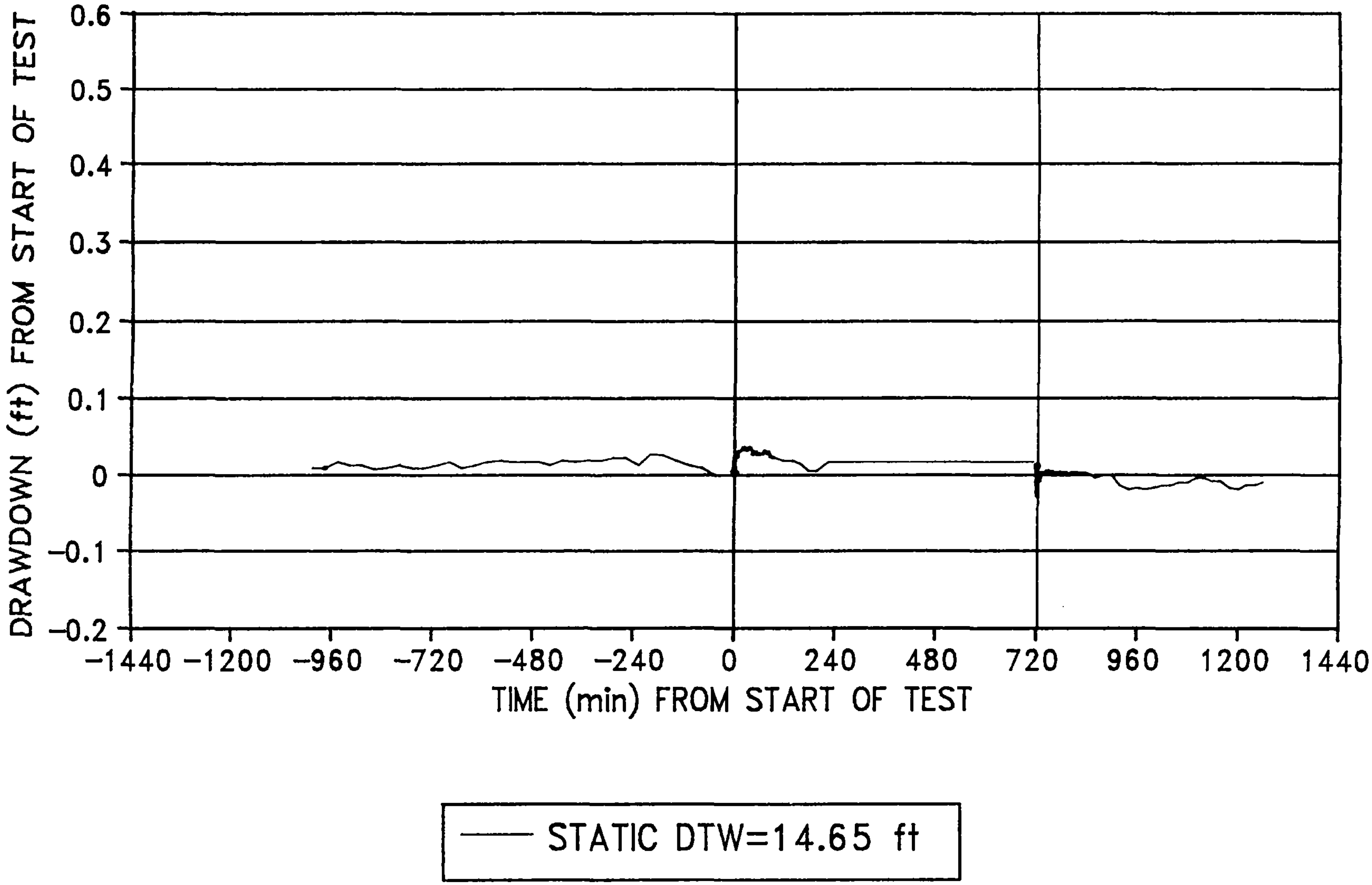


FIGURE E-1

Q=75gpm
Shallow Well

NAVISTAR: GM27s UNCORRECTED DRAWDOWN
BACKGROUND, PUMPTEST, RECOVERY



Deep Test

r=5.3ft
Q=75gpm
Deep Well

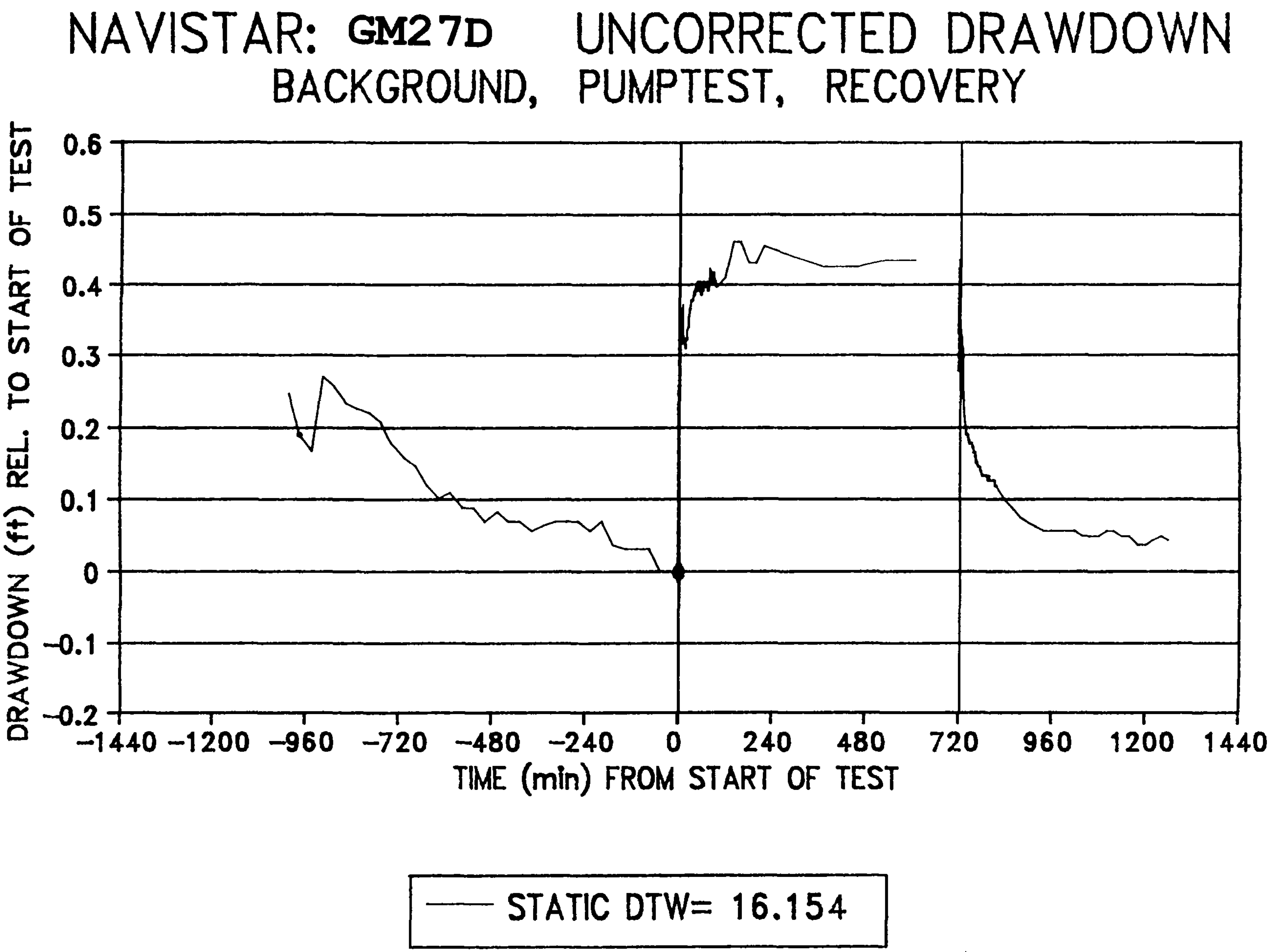


FIGURE E-3

Deep Test

r=20.3ft
Q=75gpm
Shallow Well

NAVISTAR: GM28S UNCORRECTED DRAWDOWN

BACKGROUND, PUMPTEST, RECOVERY

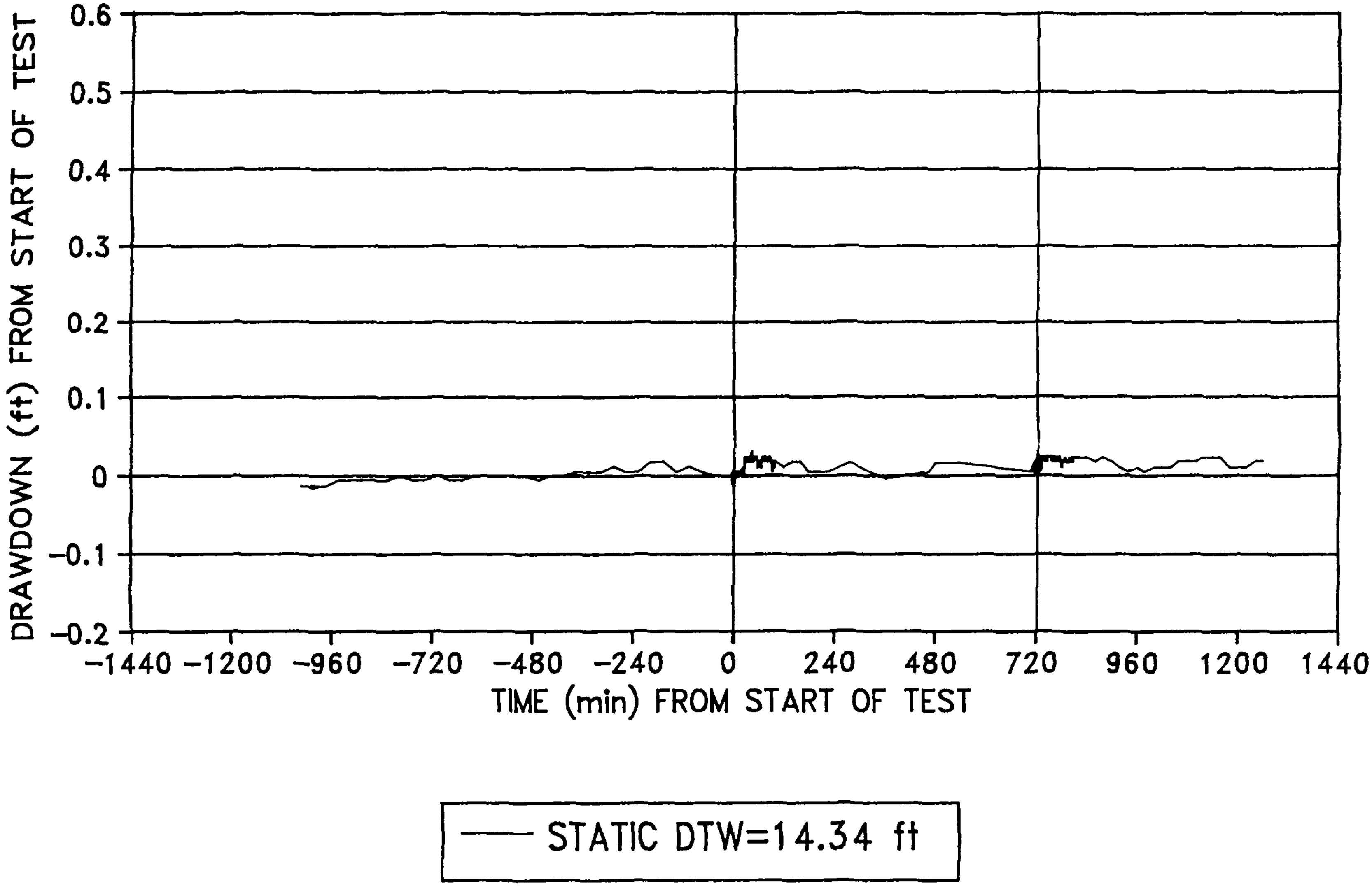


FIGURE E-4

De Te r=1 .9f
Q=75gpm
Deep Well

NAVISTAR: **GM28D** UNCORRECTED DRAWDOWN

BACKGROUND, PUMPTEST AND RECOVERY

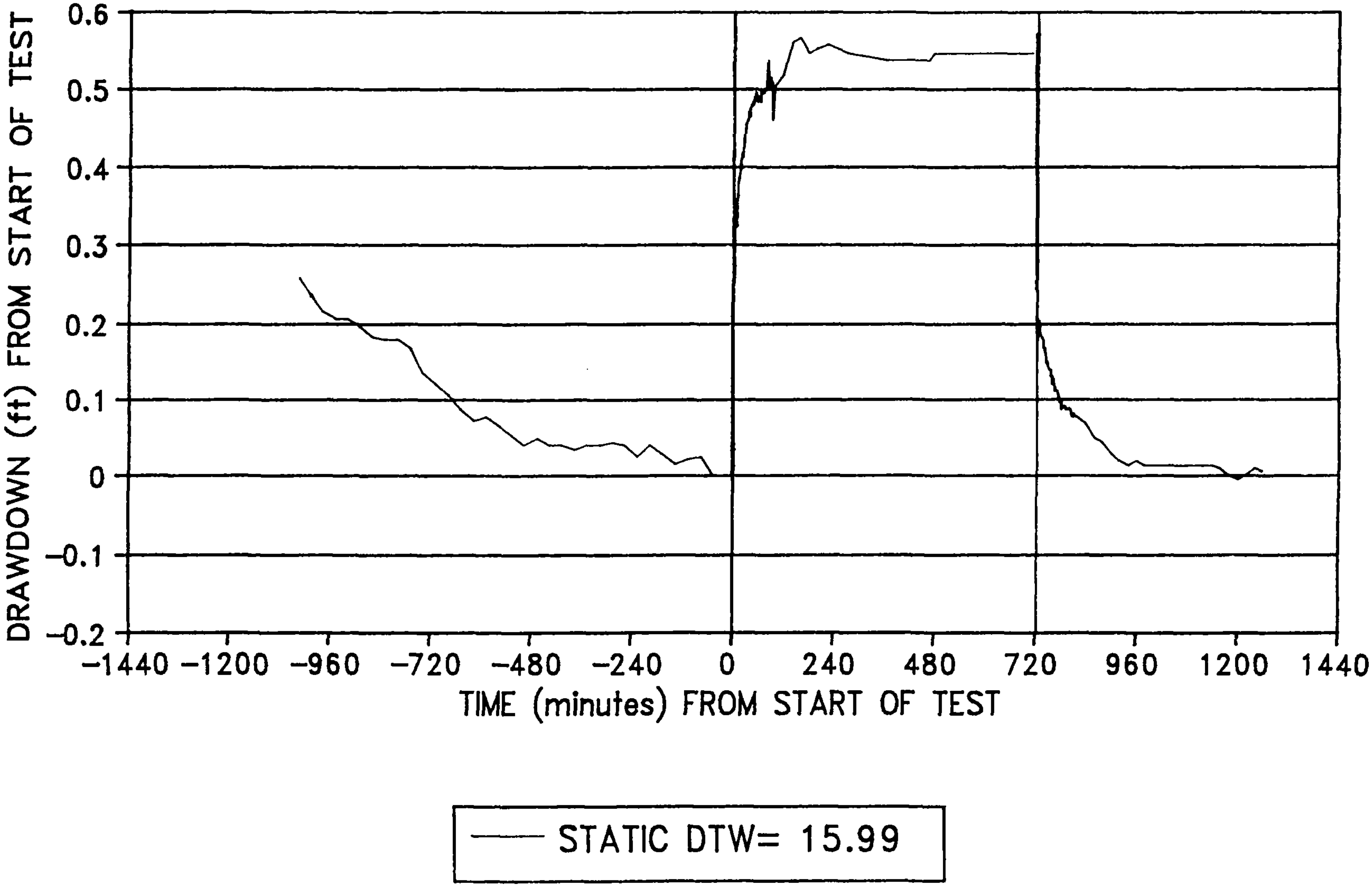


FIGURE E-5

Deep Test

r=30.6ft
Q=75gpm
Shallow Well

NAVISTAR: GM29S UNCORRECTED DRAWDOWN

PUMPTEST

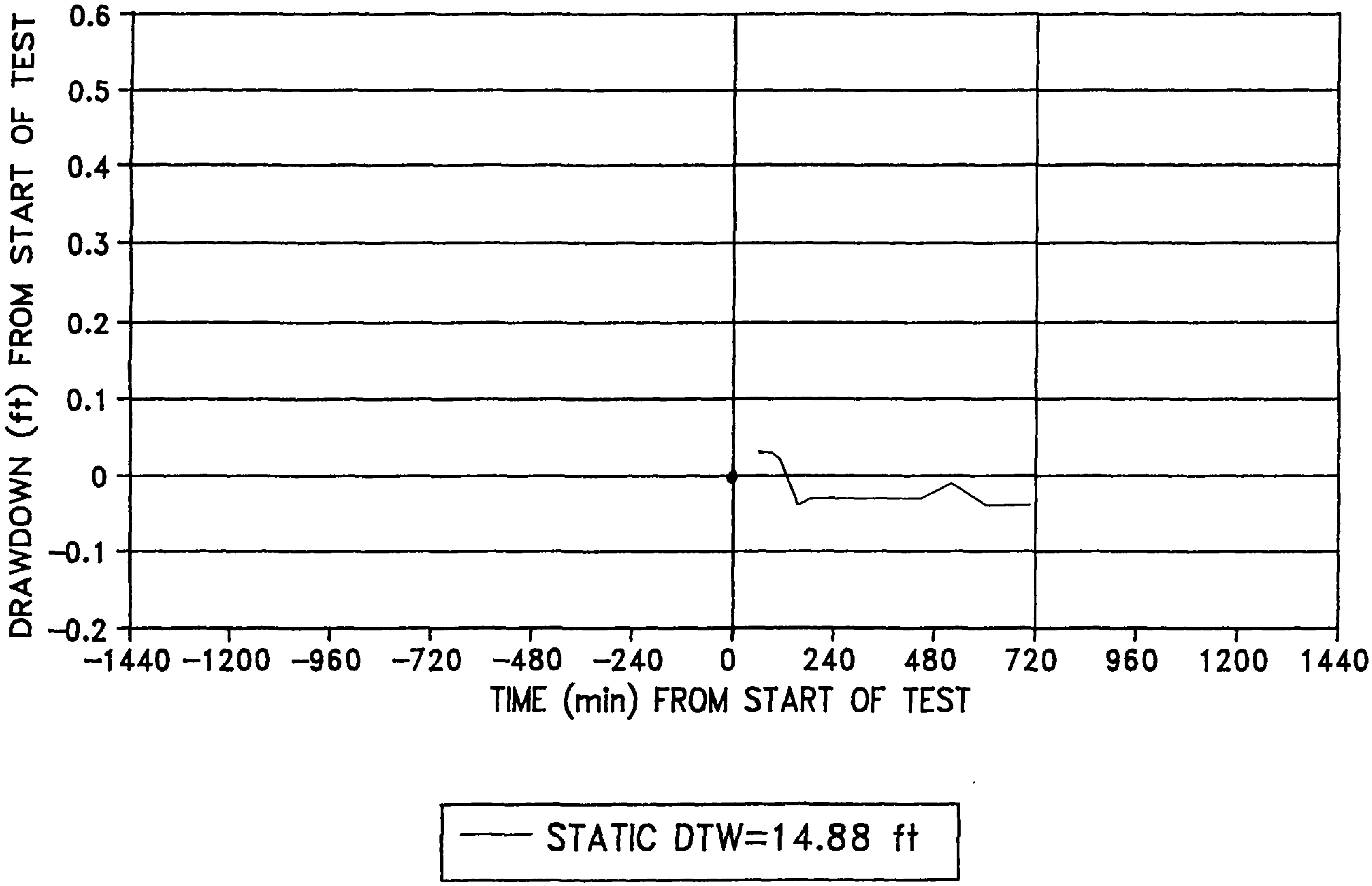


FIGURE F-6

Deep Test

r=36.9ft
Q=75gpm
Deep Well

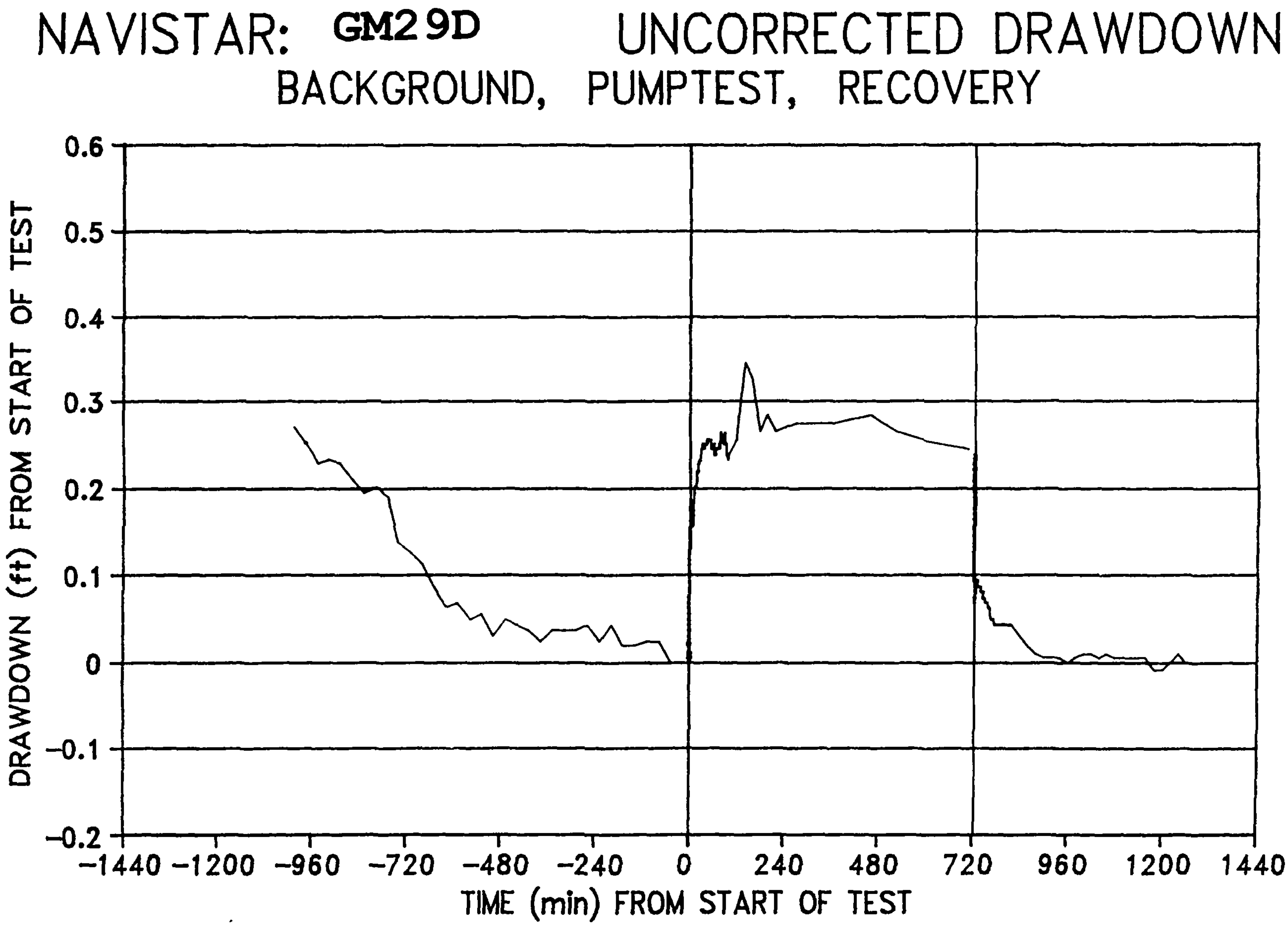


FIGURE F-7

NAVISTAR: GM23D UNCORRECTED DRAWDOWN
PUMPTEST

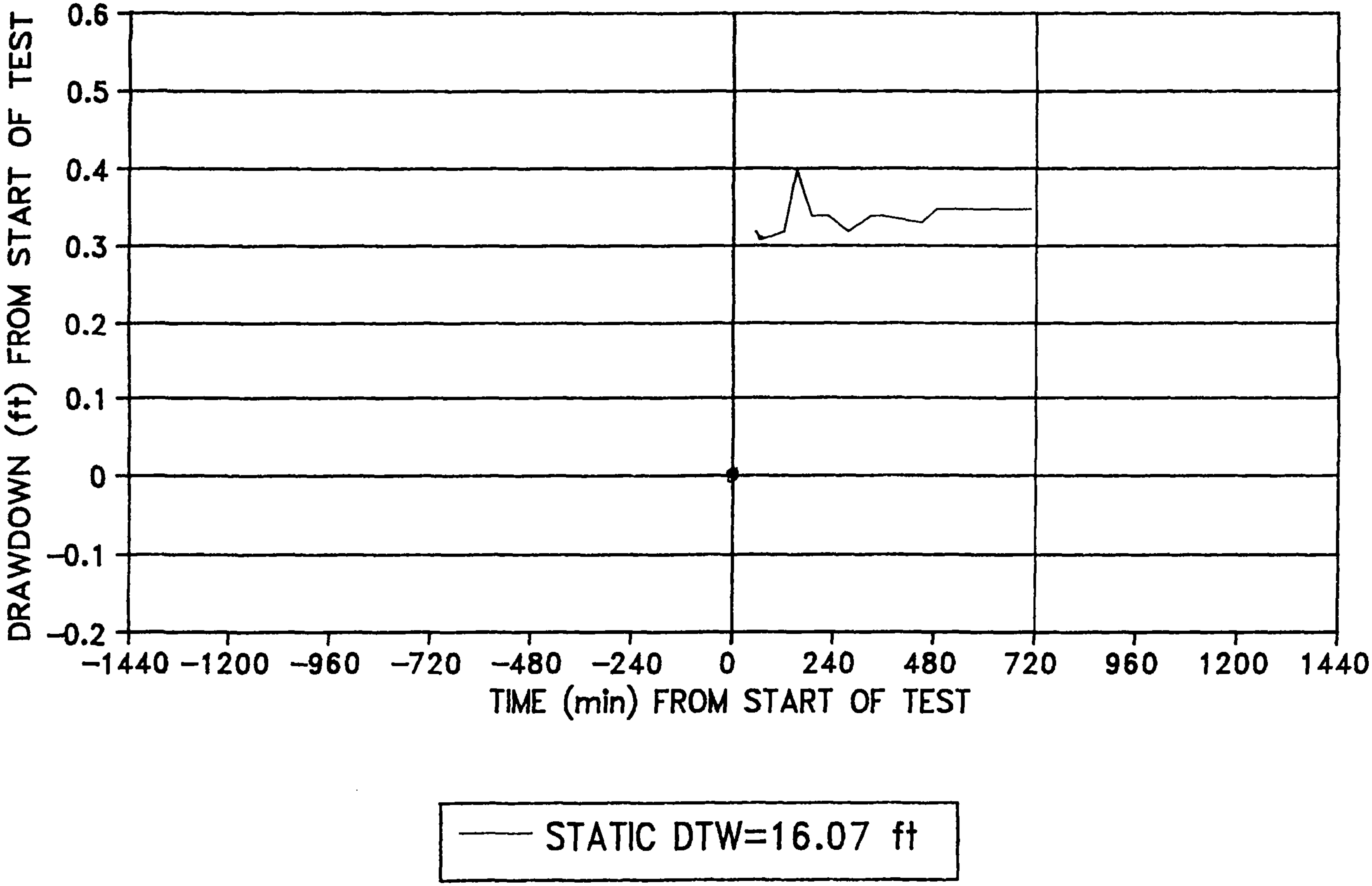
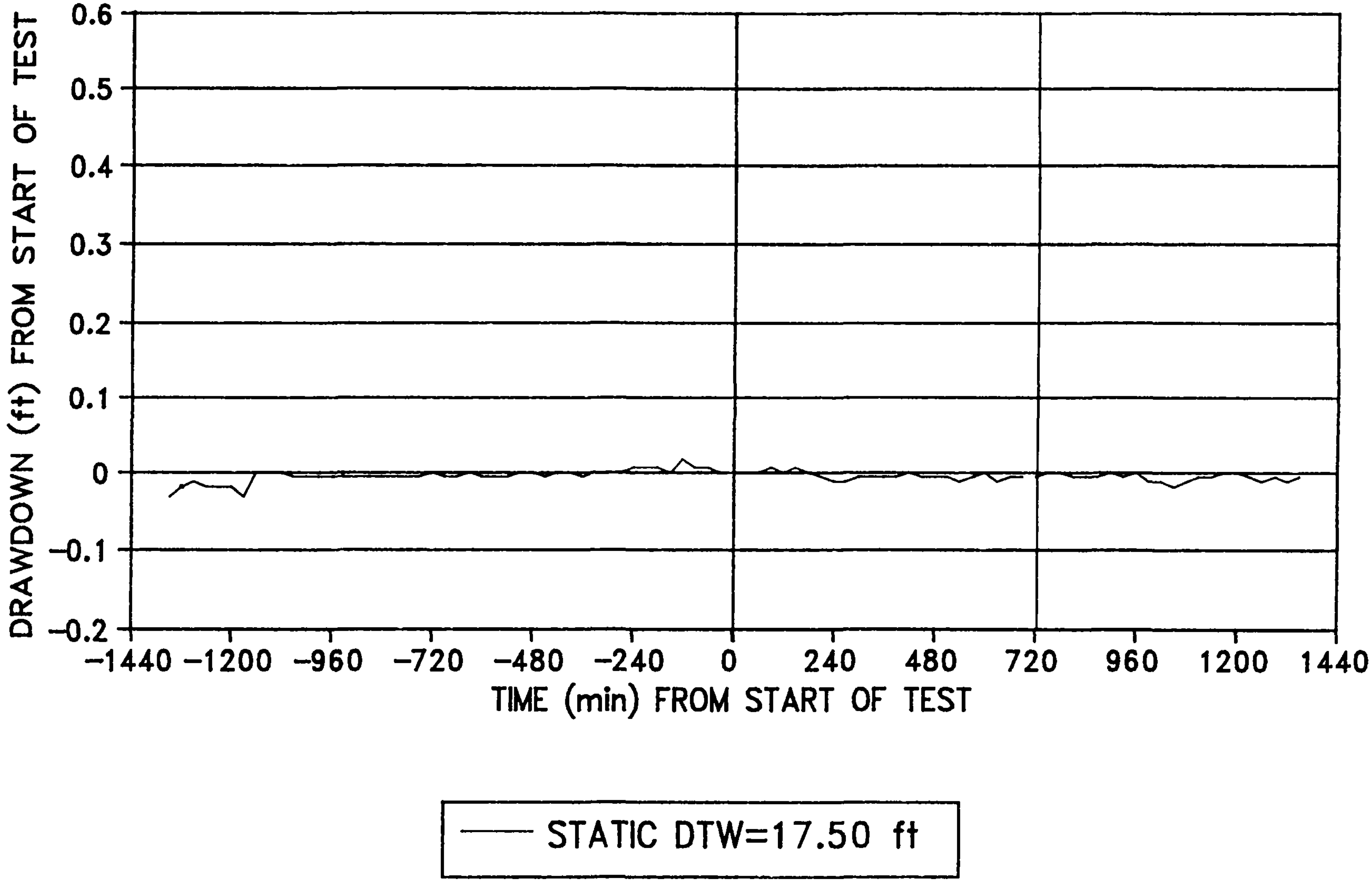


FIGURE F-8

De[illegible] Te[illegible] [illegible]=2[illegible]t
Q=75gpm
Shallow Well

NAVISTAR: GM22S UNCORRECTED DRAWDOWN
BACKGROUND, PUMPTEST, RECOVERY

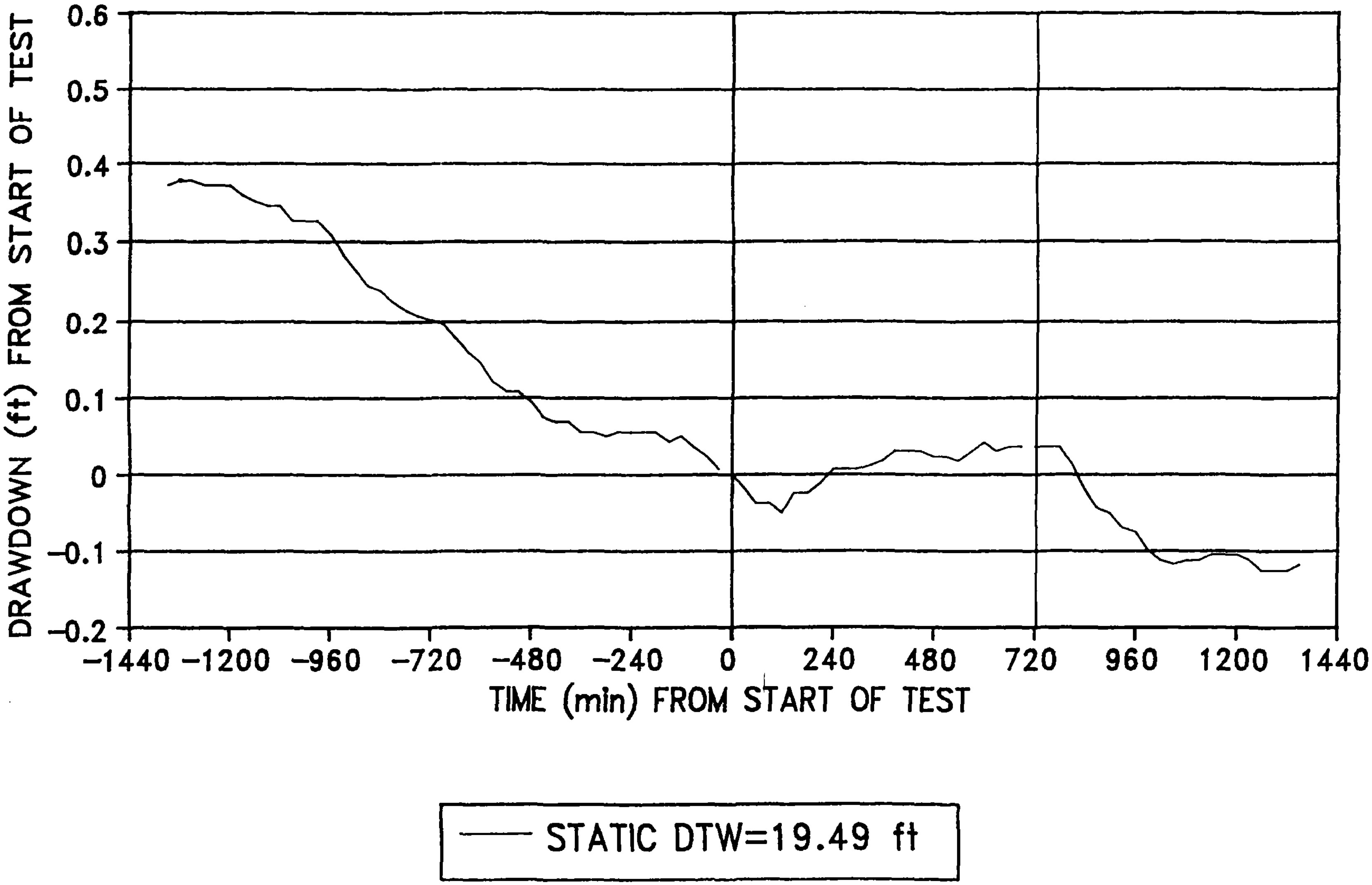


Deep Test

r=252ft
Q=75gpm
Deep Well

NAVISTAR: GM22D UNCORRECTED DRAWDOWN

BACKGROUND, PUMPTEST, RECOVERY



Deep Test

r= ft
Q=75gpm
Shallow Well

NAVISTAR: GM19S UNCORRECTED DRAWDOWN
BACKGROUND, PUMPTEST, RECOVERY

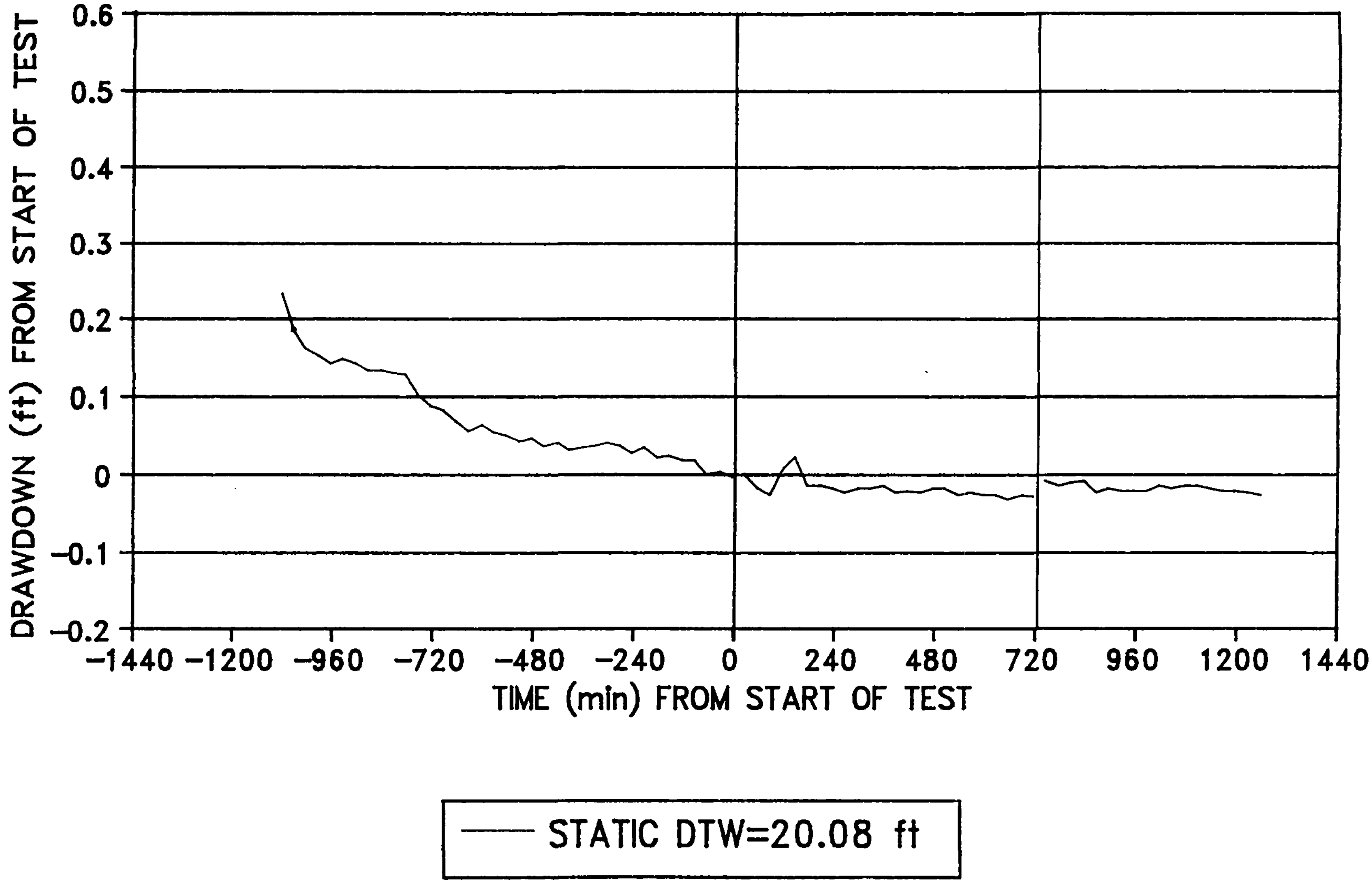


FIGURE F-11

~~Deep Test~~ =8 ft
Q=75gpm
Deep Test

NAVISTAR: GM19D UNCORRECTED DRAWDOWN
BACKGROUND, PUMPTEST, RECOVERY

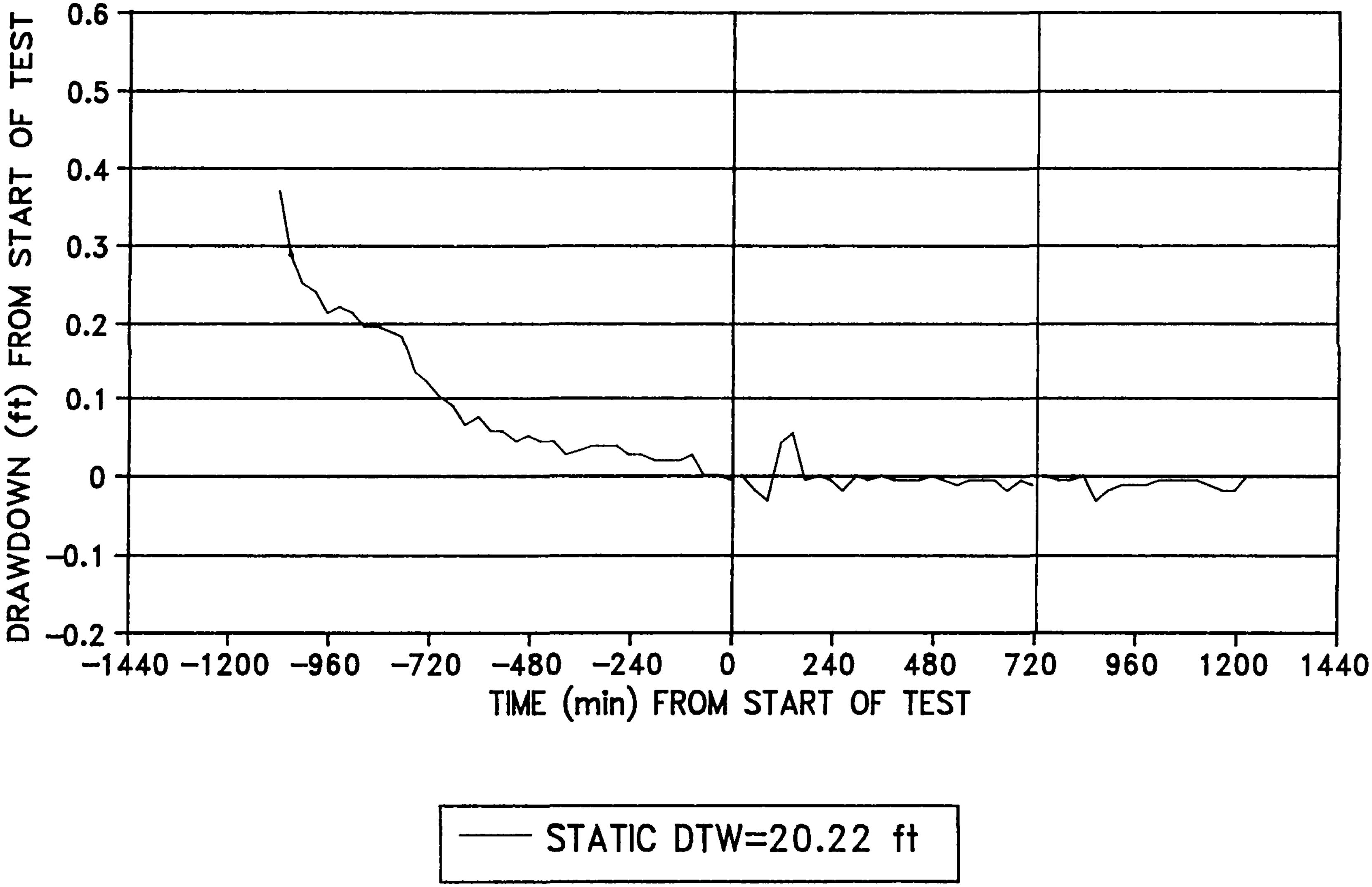


FIGURE E-12

APPENDIX F

Lower Sand and Gravel Unit MODFLOW Analysis

INNER GRID FOR MODFLOW MODEL

COLUMNS 9-43, ROWS 1-35

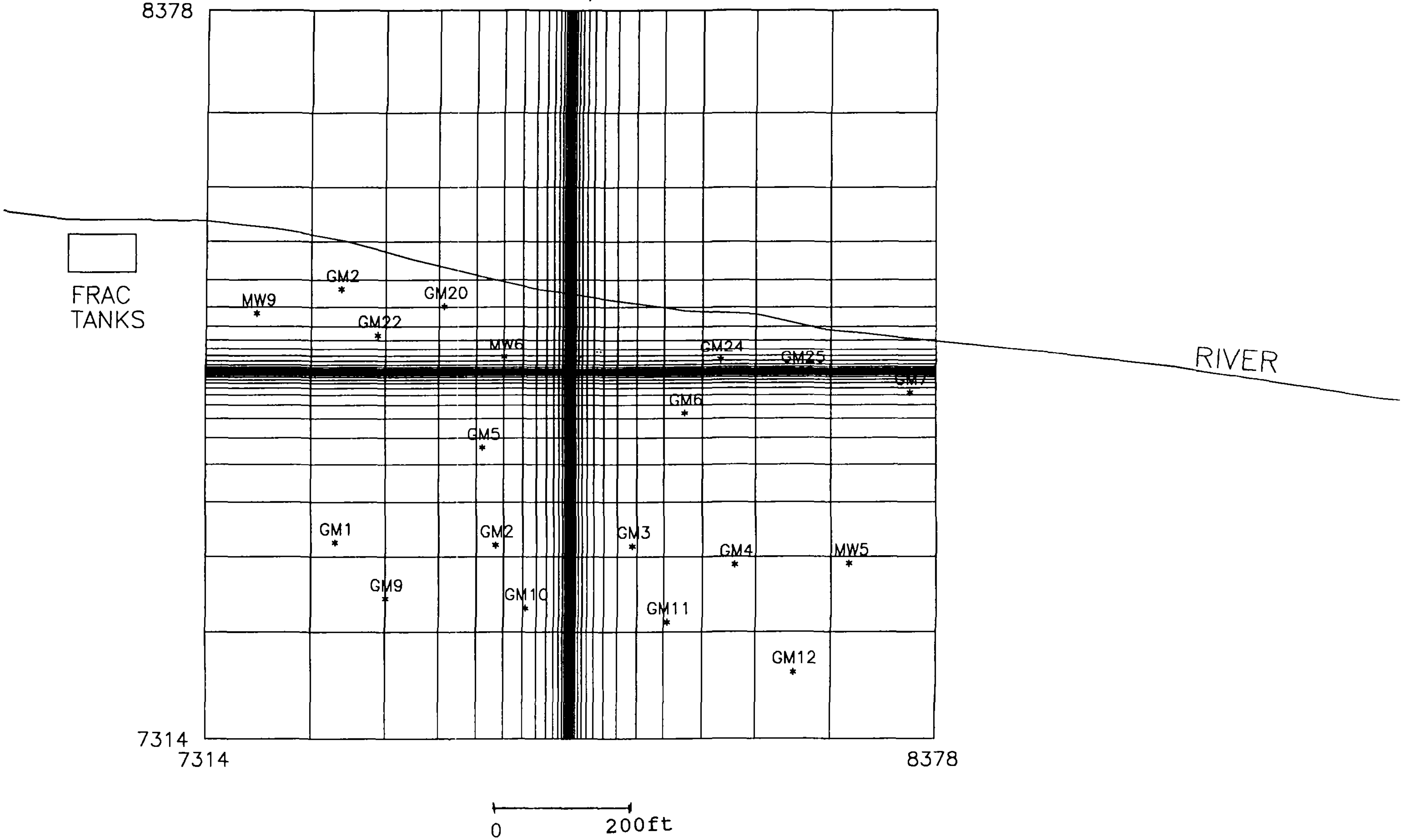
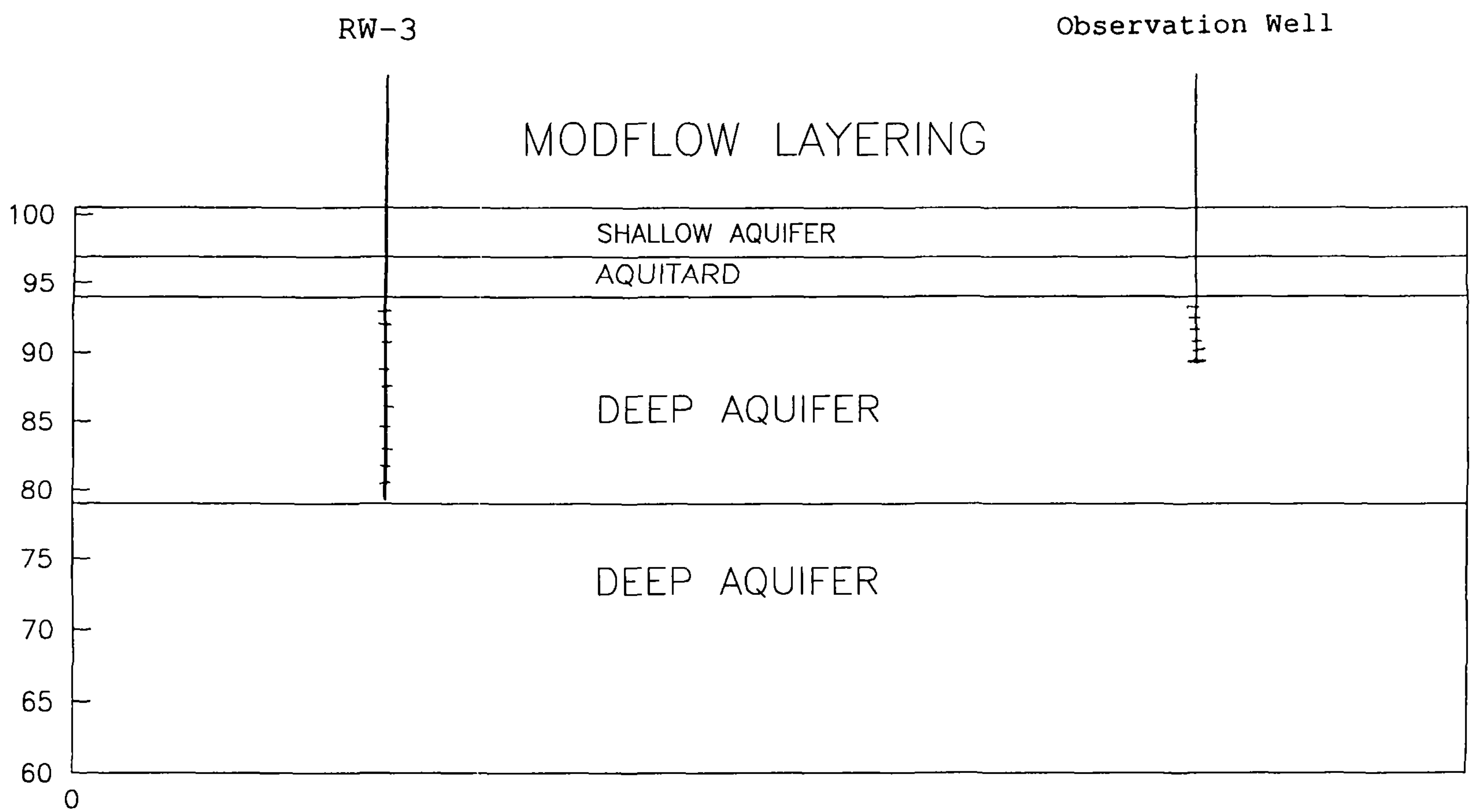


FIGURE F-1


RW-3
Observation Well
MODFLOW LAYERING
SHALLOW AQUIFER
AQUITARD
DEEP AQUIFER
DEEP AQUIFER
100
95
90
85
80
75
70
65
60
0

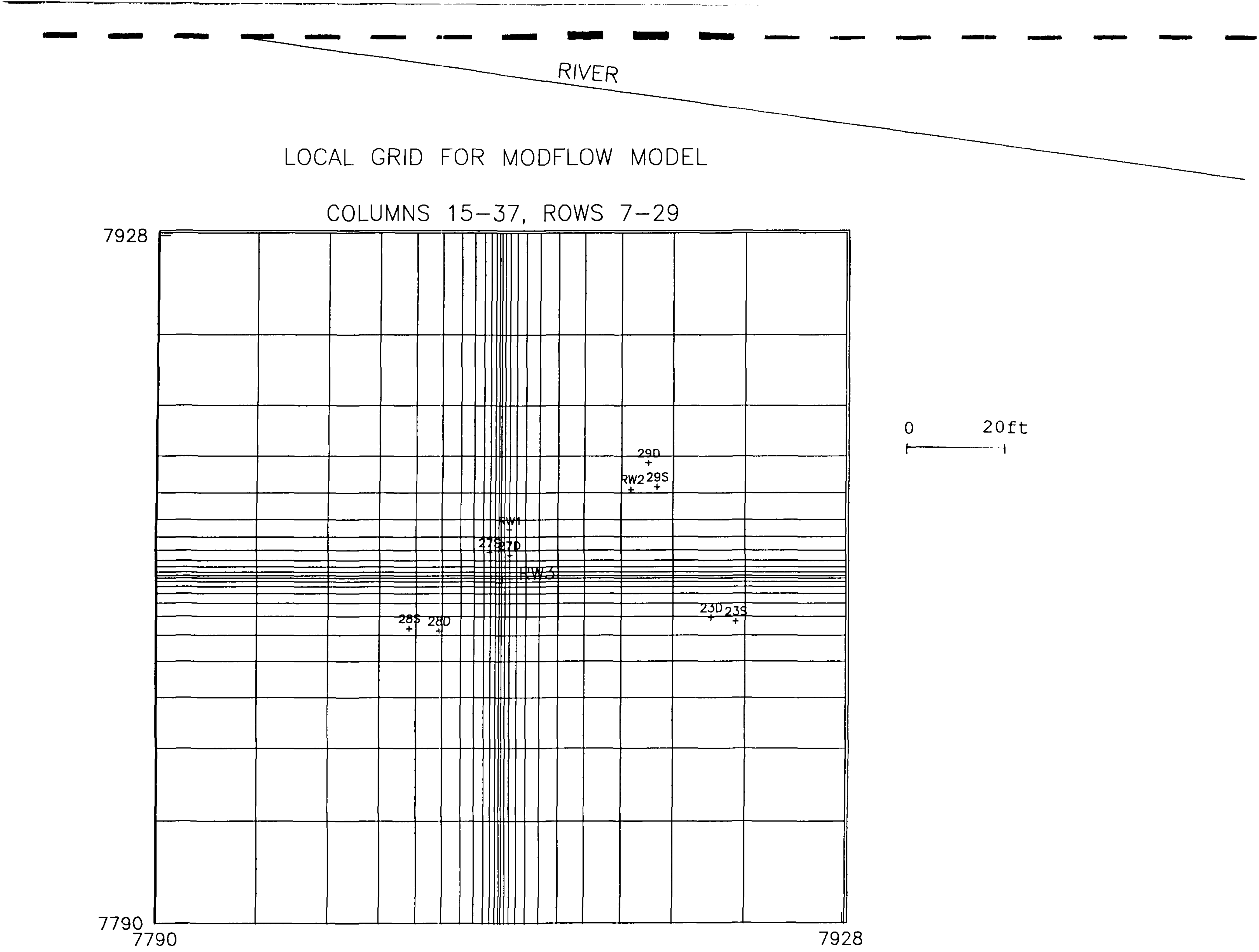

RIVER
LOCAL GRID FOR MODFLOW MODEL
COLUMNS 15-37, ROWS 7-29
7928
7790
7790
7928
0
20ft
29D
RW2
29S
RW1
27S
27D
RW3
28S
28D
23D
23S

FIGURE F-3

r=5.3 ft
Q=75 gpm
Deep Well

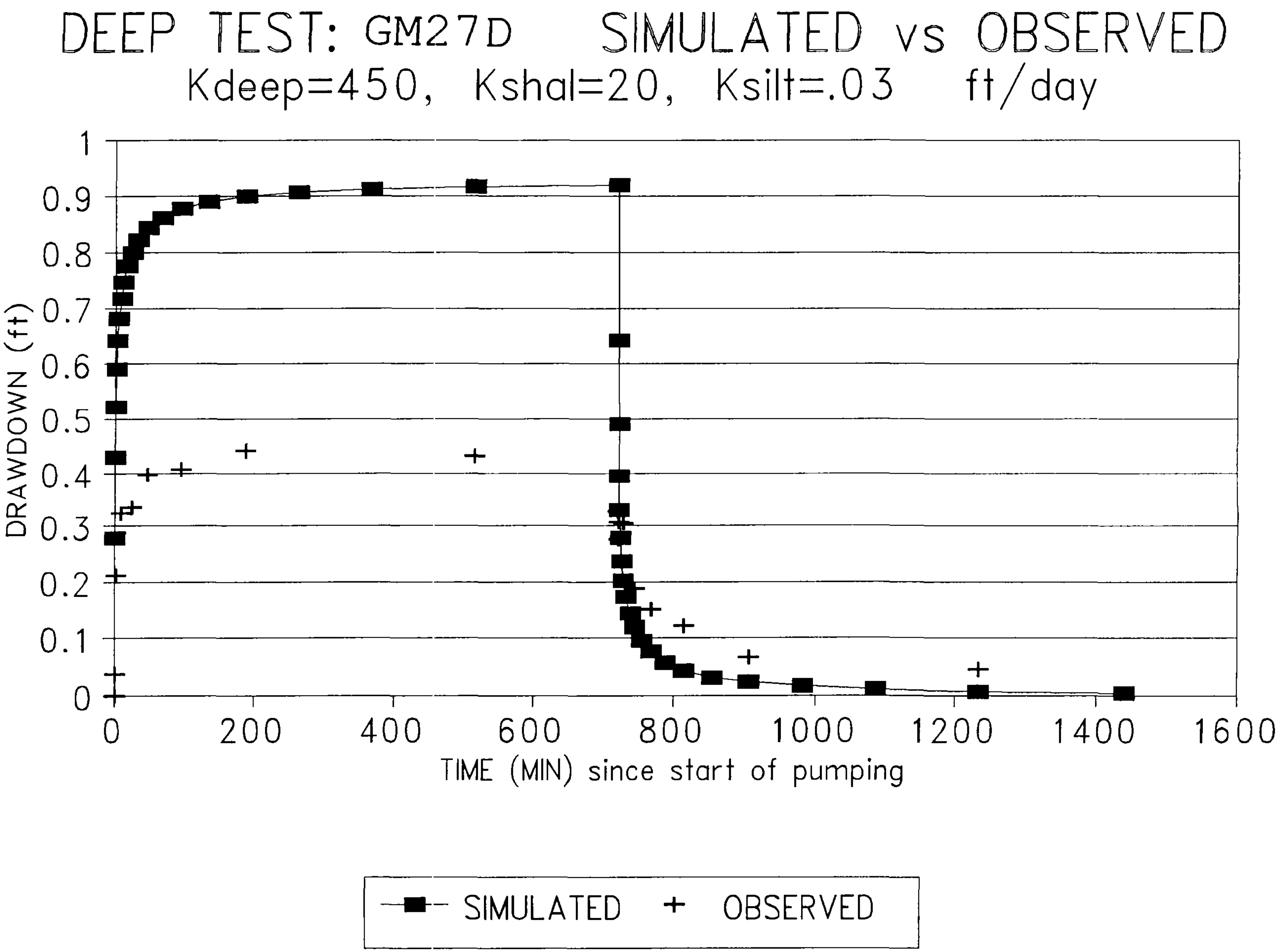


FIGURE F-4

Drawdown Only

r=5.3 ft
Q=75 gpm
Deep Well

DEEP TEST: GM27D SEMILOG SIMUL vs OBS

Kdeep=450, Kshal=20, Ksilt=.03 ft/day

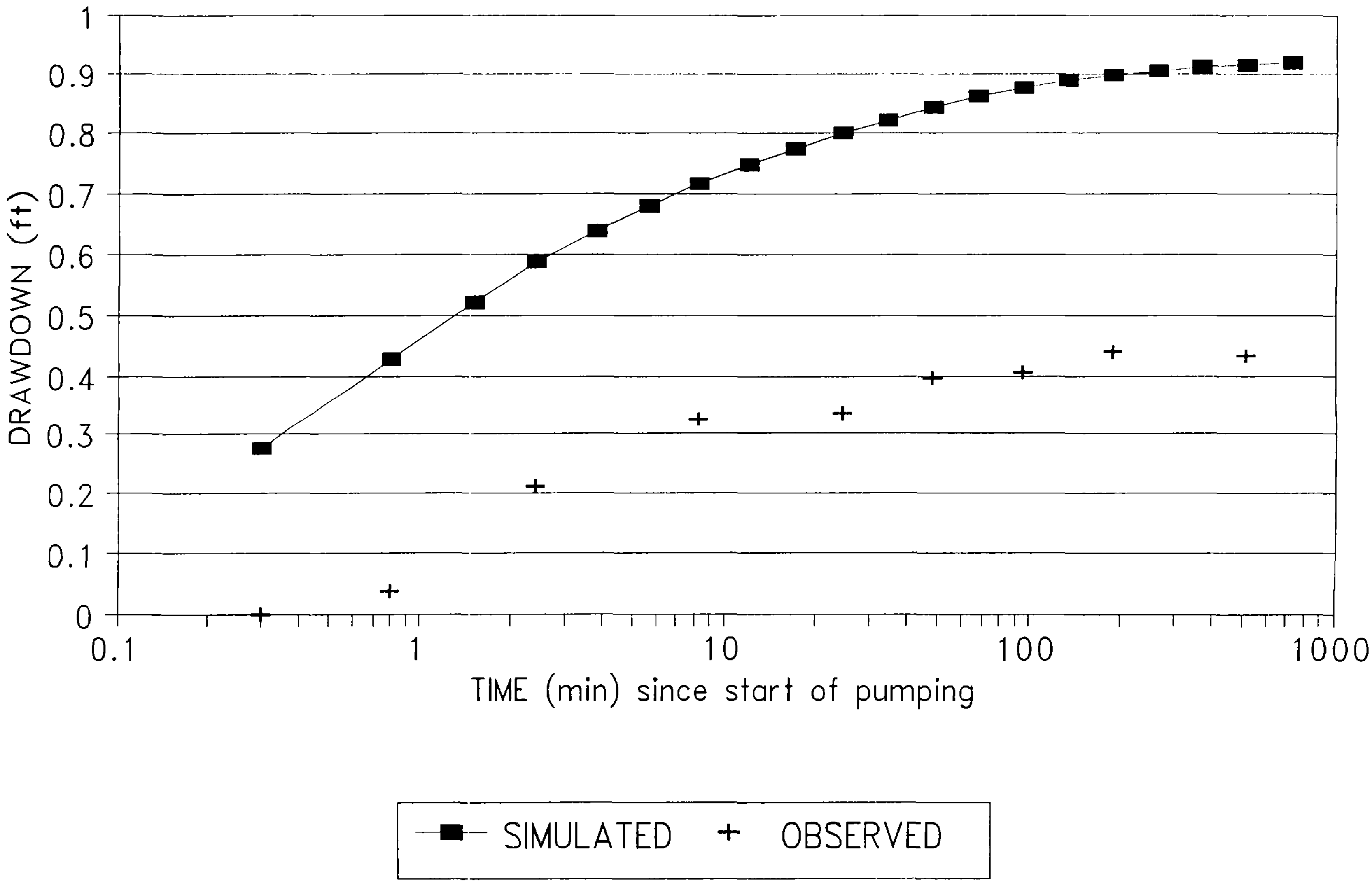


FIGURE F-5

Drawdown and Recovery r=[illegible] 9
Q=75 gpm
Deep Well

DEEPT TEST:GM28D SIMULATED vs OBSERVED

Kdeep=450, Kshal=20, Ksilt=.03 ft/day

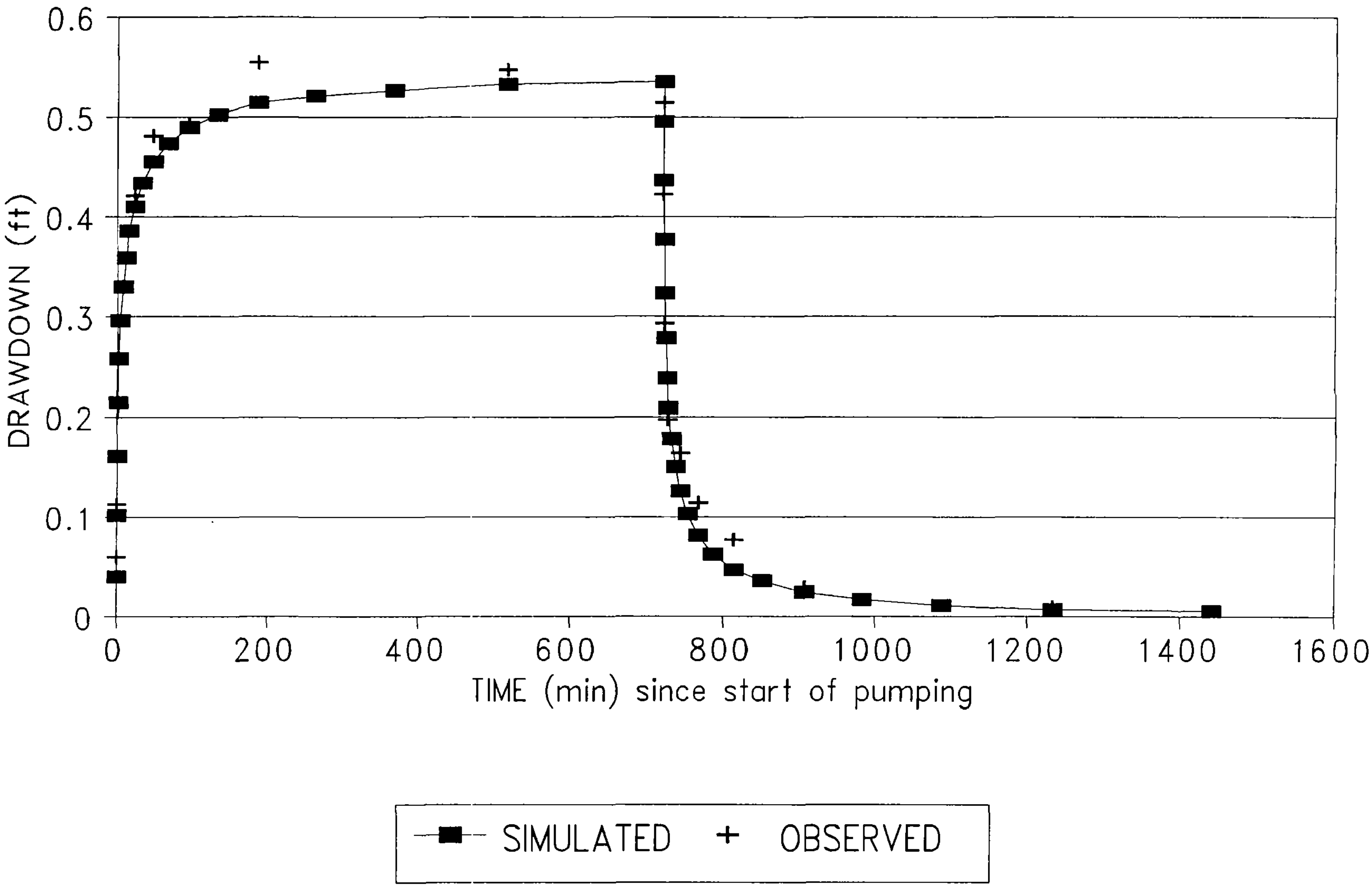


FIGURE F-6

Q=75 gpm
Deep Well

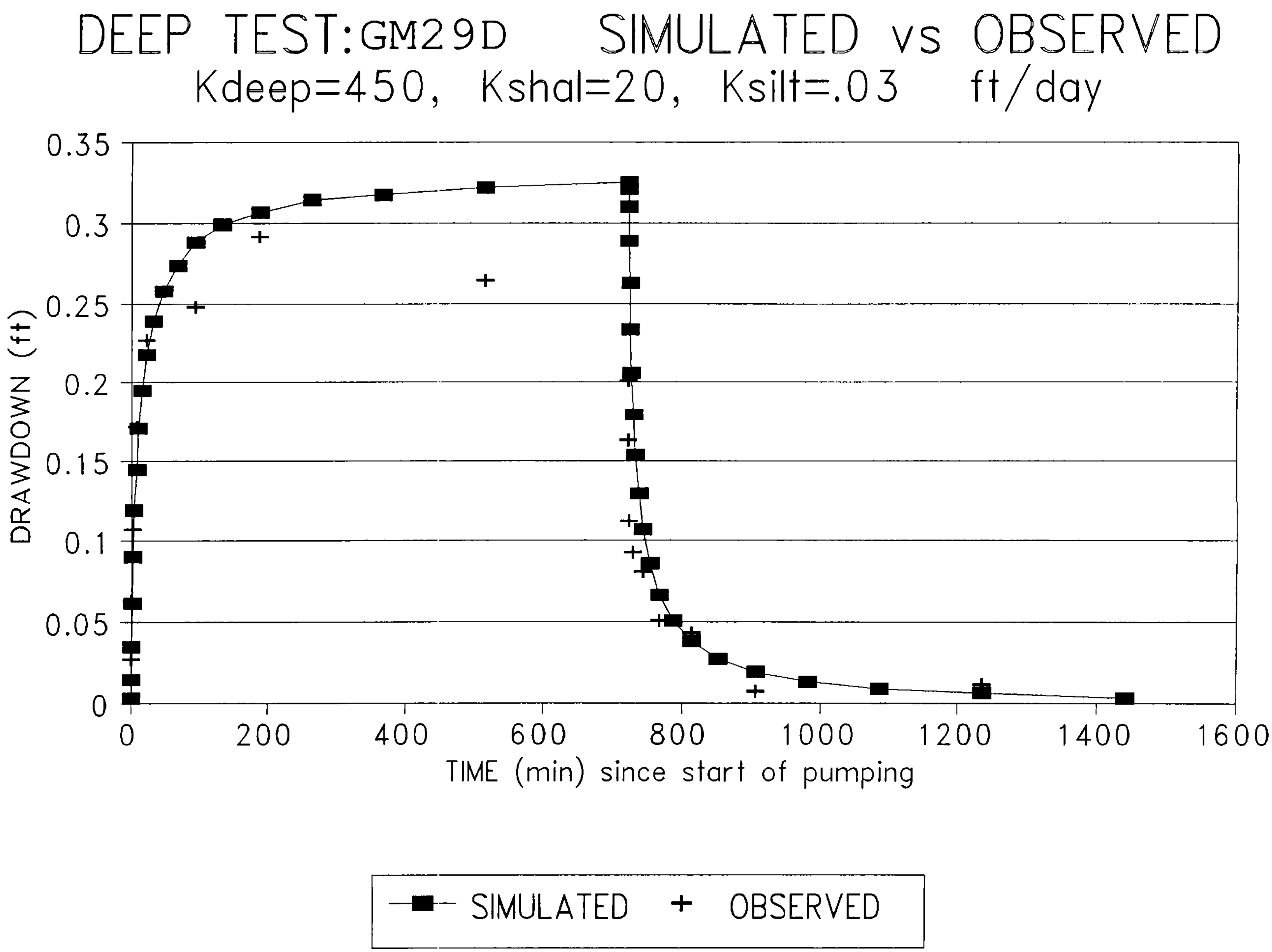


FIGURE F-7

Drawdown and Recovery

r= 9
Q=75 gpm
Deep Well

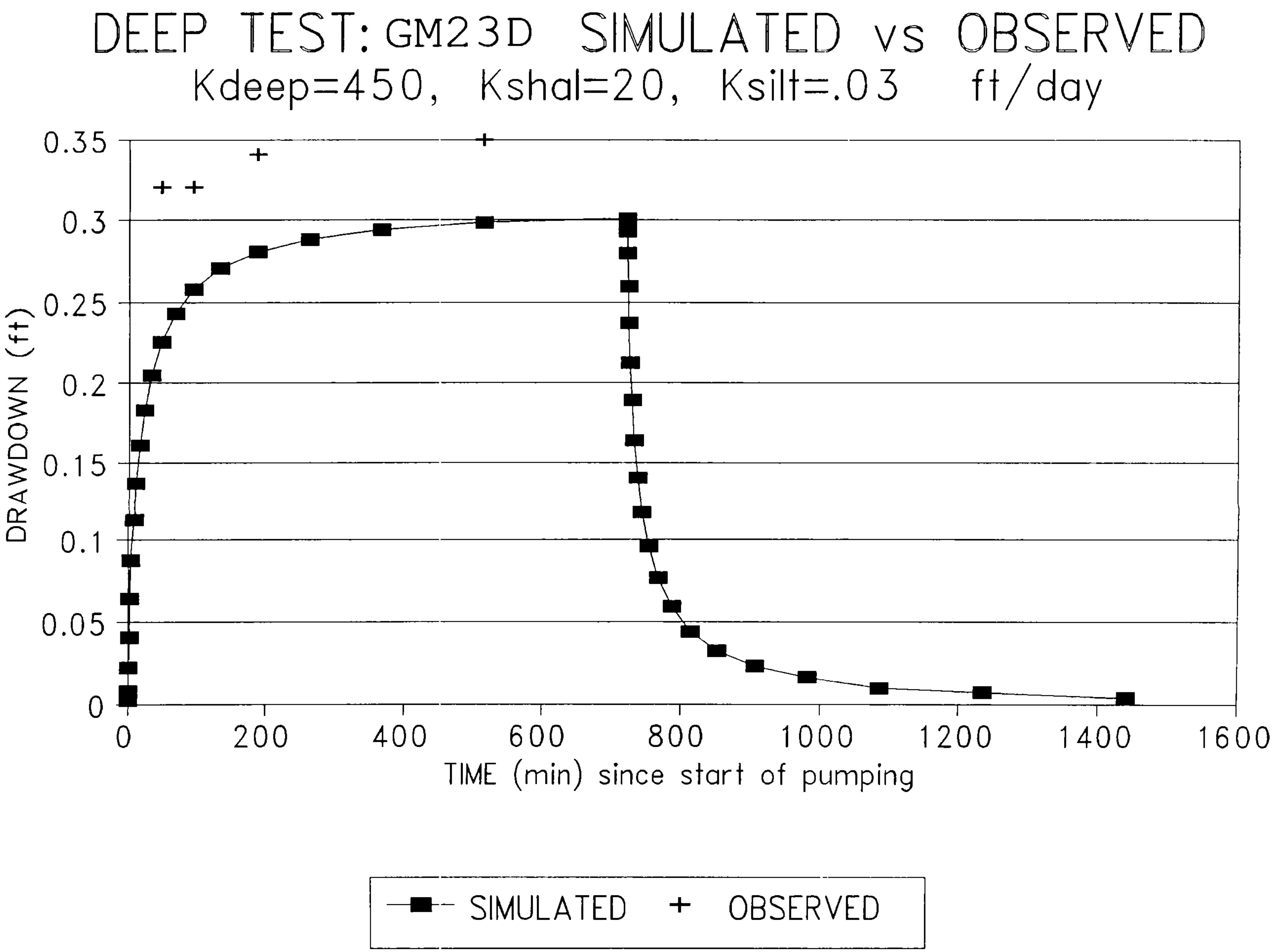


FIGURE F-8

Dra wn d cov 15 ft
Q=75 gpm
Deep Well

DEEP TEST:GM28D SEMILOG SIMUL vs OBS
Kdeep=450, Kshal=20, Ksilt=.03 ft/day

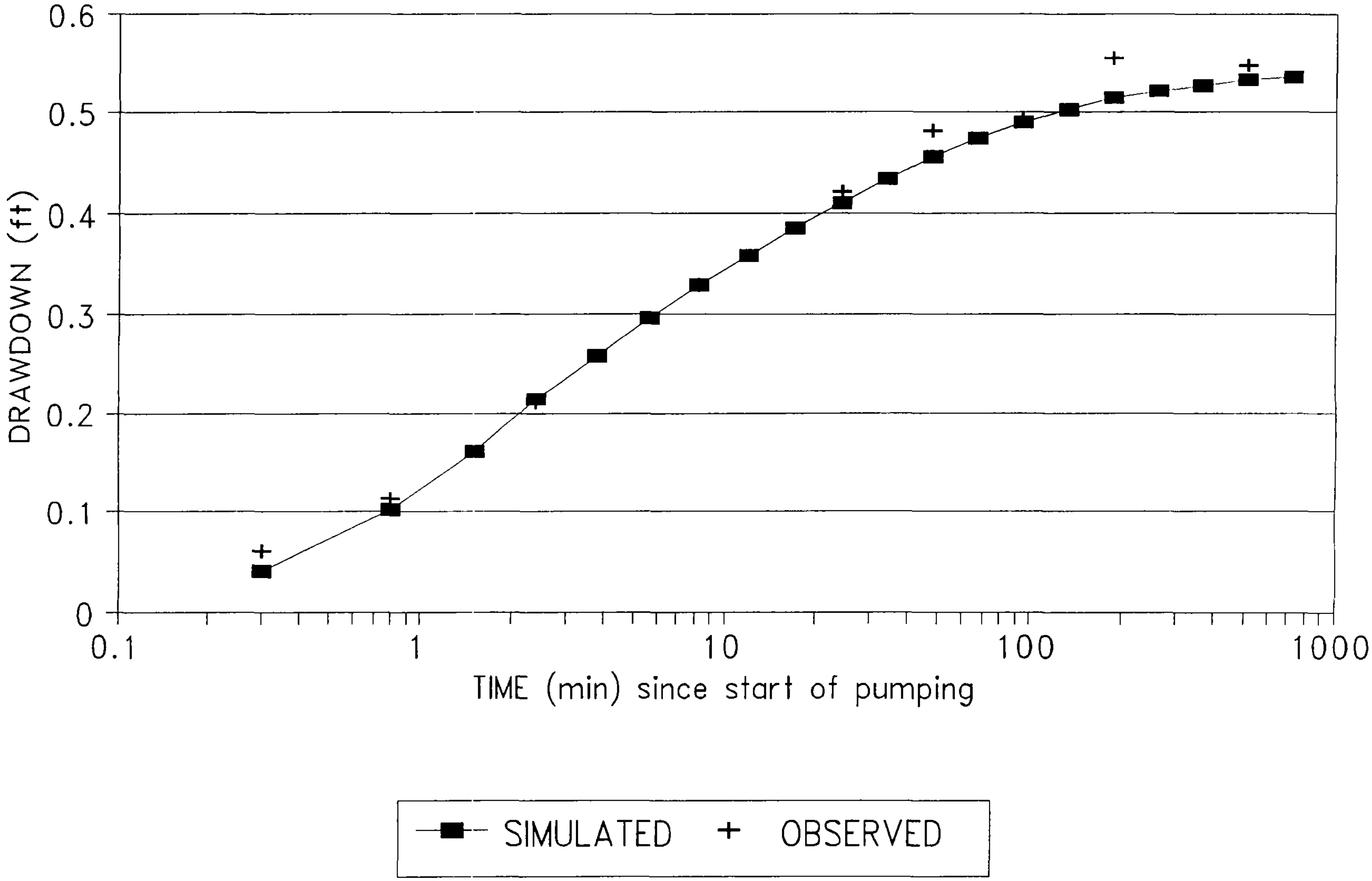


FIGURE F-9

Q=75 gpm
Deep Well

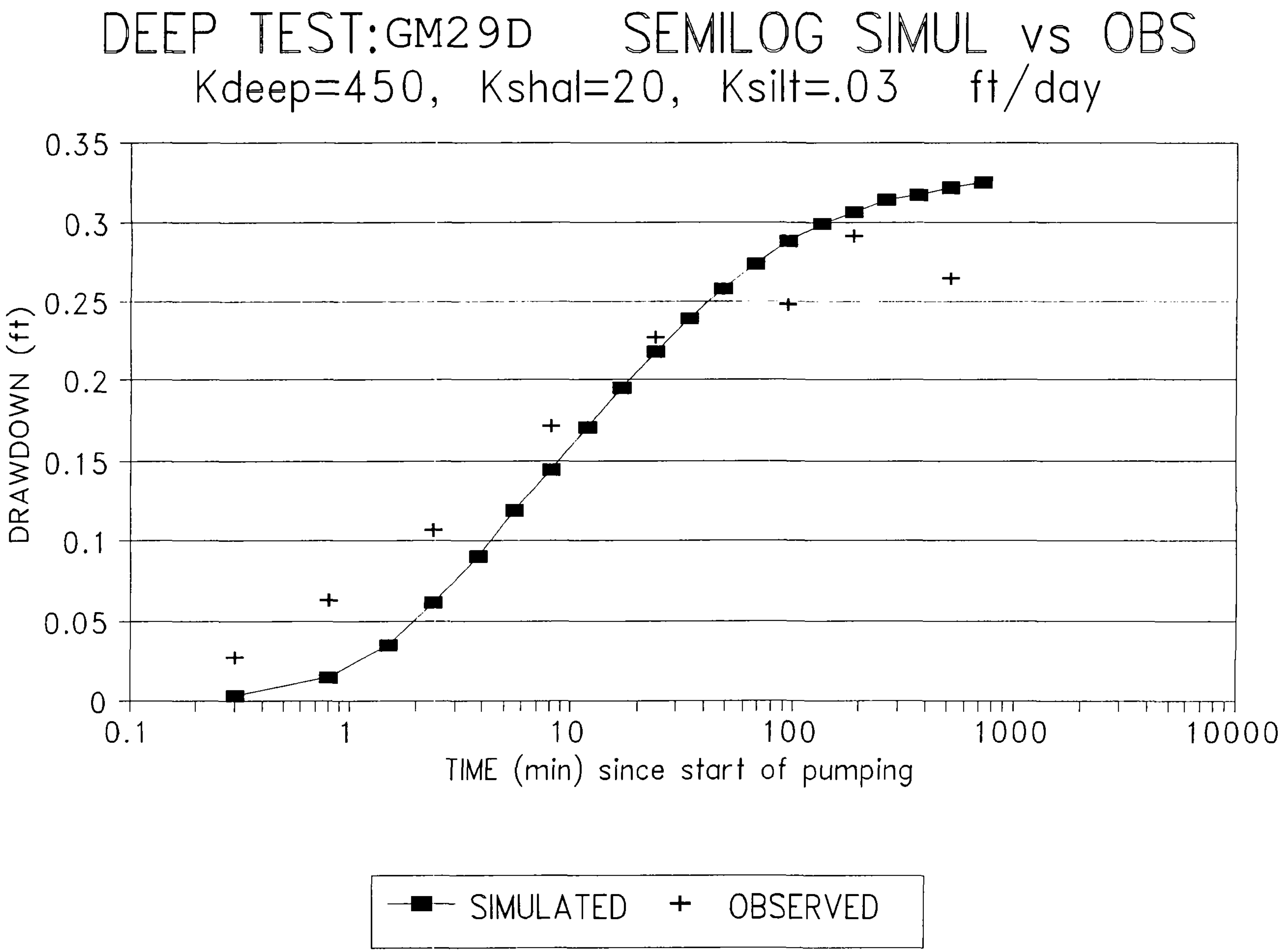


FIGURE F-10

Drawdown only

r=[illegible].9 ft
Q=75 gpm
Deep Well

DEEP TEST: GM23D SEMILOG SIMUL vs OBS

Kdeep=450, Kshal=20, Ksilt=.03 ft/day

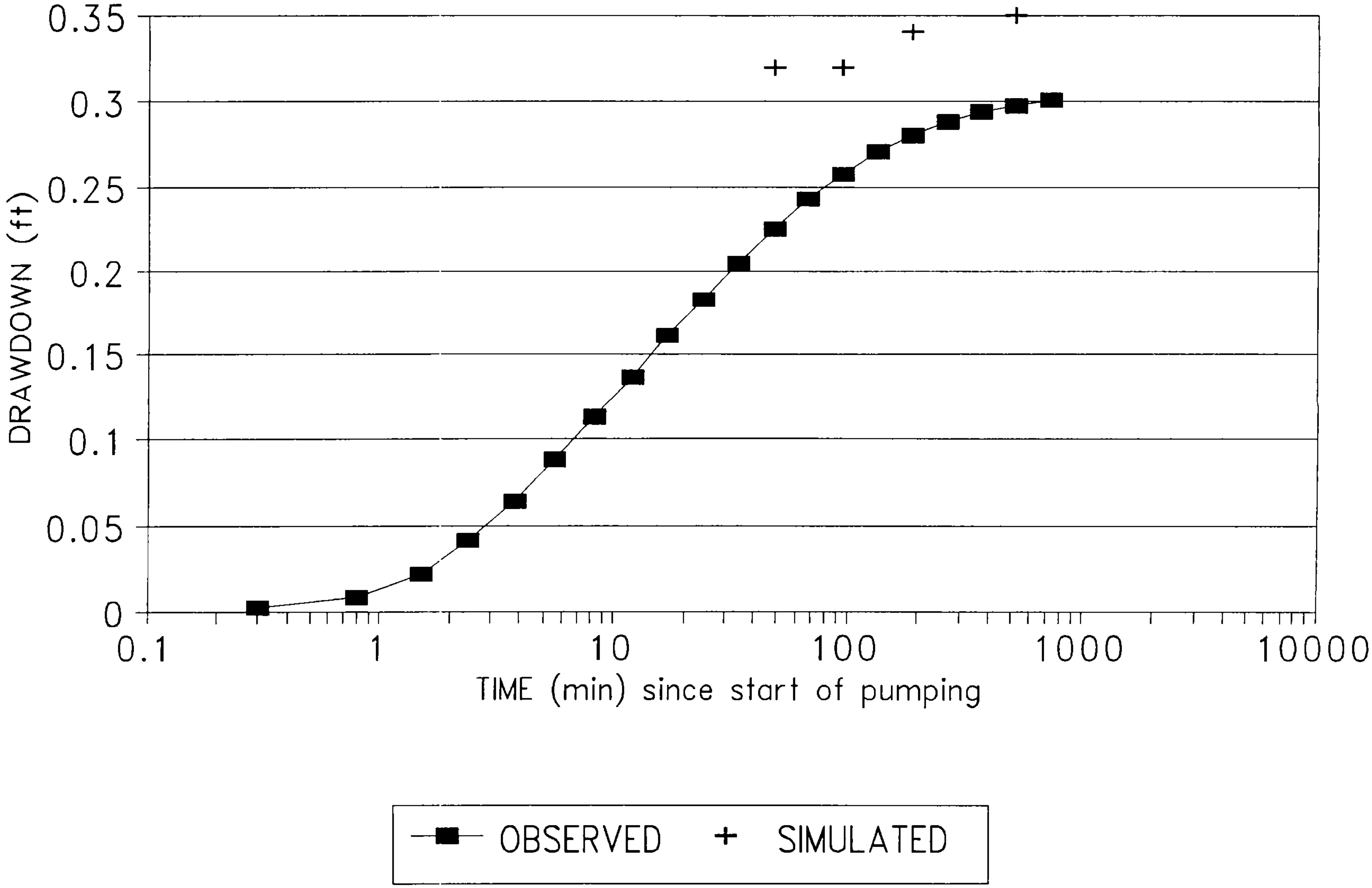


FIGURE F-11

Dr[illegible]ow[illegible]nd[illegible]ecc[illegible]y [illegible]=5 [illegible]ft

Q=75 gpm
Shallow Well

DEEP TEST: GM27S SIMULATED vs OBSERVED

Kdeep=450, Kshal=20, Ksilt=.03 ft/day

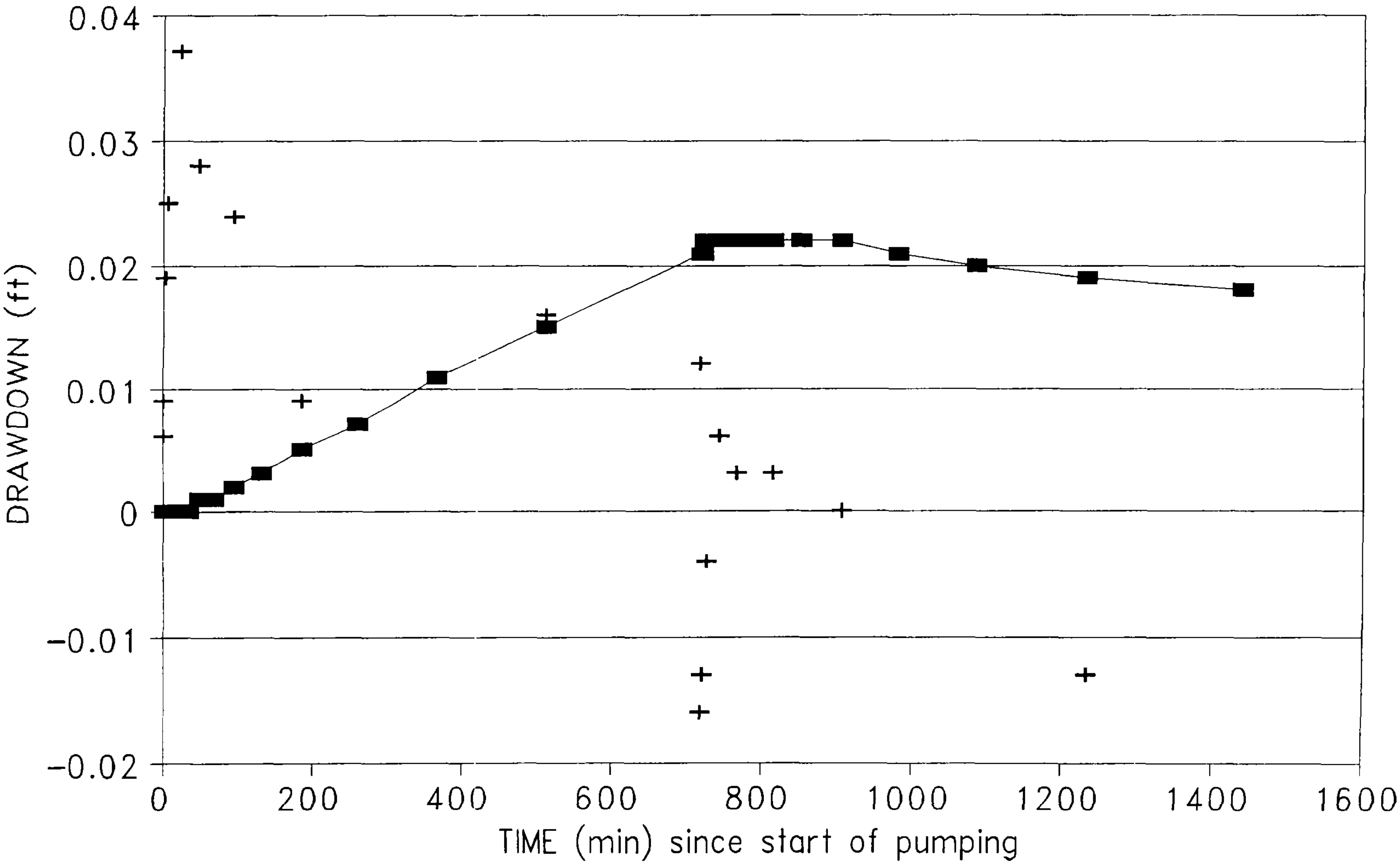


FIGURE F-12

Draw[illegible]wn [illegible]d [illegible]cov[illegible] 20 [illegible] ft
Q=75 gpm
Shallow Well

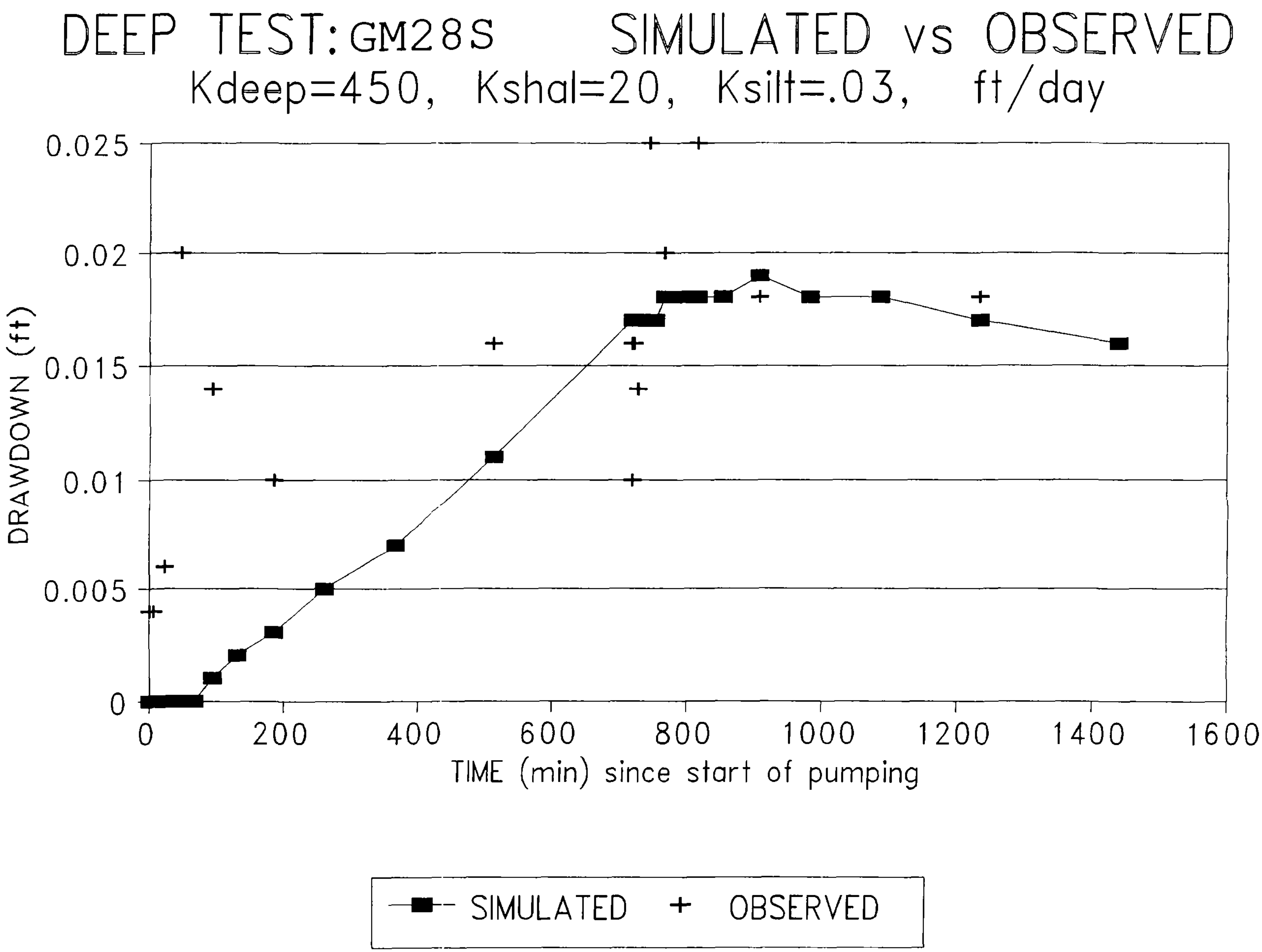


FIGURE F-13